## **Course Syllabus: B38EM – Introduction to Electricity and Magnetism**

## **Heriot Watt University, Spring 2021 (Edinburgh Campus)**

**Lecture**: Room/Hours: <https://timetable.hw.ac.uk/WebTimetables/LiveED/login.aspx>

**Lectures**: **Tuesday,** 10:00, Lecture Theater 4, 45 minutes,

**Friday,** 10:00, Online, 1 hour and 45 minutes;

**Tutorials and labs**: **Monday,** 16:00, EM252, 45 minutes.

**Instructors**: Dr. Dimitris Anagnostou, PhD, Associate Professor, ISSS (Edinburgh Campus)

Dr. Yuan Ding, PhD, Assistant Professor, ISSS (Edinburgh Campus)

Other campuses: Please check respective schedules.

**Contacts:** EM2.12, [d.anagnostou@hw.ac.uk](mailto:d.anagnostou@hw.ac.uk), 0131 451 4344,

https://microwaves.site.hw.ac.uk/dr-dimitris-anagnostou/

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https://microwaves.site.hw.ac.uk/dr-yuan-ding/

**Office hours**: Anytime the instructor’s door is open or by email appointment.

Please **prefer email** for a first contact for the taught material, h/w problems, etc.

Check Canvas and your [@hw.ac.uk](mailto:s@hw.ac.uk) email account **every day** for useful info.

**TAs**: Qassim Abdullahi: Office: EM2.34, email: [qsa1@hw.ac.uk](mailto:qsa1@hw.ac.uk)

Kai Xu: Office: EM2.34, email: [kx1@hw.ac.uk](mailto:kx1@hw.ac.uk)

Yuepei Li: Office: EM2.34, email: [yl12@hw.ac.uk](mailto:yl12@hw.ac.uk)

To be updated,

**Textbook**: *Elements of Electromagnetics* by Alexander and Sadiku, 7th ed, 978-0190698614

(2nd text): *Fundamentals of Applied E/M* by Ullaby, Michielssen, Ravaioli, 7th ed., 978-1292082448.

Students are responsible for all taught material regardless of their book edition. Students are encouraged to keep the books throughout their career.

**CANVAS**: Lecture slides will be posted in Canvas. To enhance students' learning experience and critical thinking, per EPS policy, *worked examples (and a few boxes) are left empty* for students to fill by lecture notetaking or from the book.

**B38EM Catalog Description**:

**Electrostatics**: Gauss law, current, magnetostatics, Ampere law, Faraday Law, electromagnetic induction. (Electric fields, electric flux density, superposition, point charge, electrostatic potential, conservative field, work, electric potential energy, potential difference, Coloumb’s Law, Gauss law, capacitance, dielectrics).

**Magnetostatics**: Current, resistance, and magnetism, conductors, drift velocity, magnetic field, Biot-Savart Law, magnetic field strength, Ampere Law, magnetic flux & flux density, magnetic circuits, magnetic properties of solids, magnetic forces, inductance, induction, transformers, EMF, Faraday Law, Lenz Law, magnetic energy.

**Electromagnetics**: Introduction to Transmission Lines, Practical TLs, Lab component, Introduction to electromagnetic waves.

**Practical examples** of Gauss Law, Helmholtz Coils, Ampere's Law (capacitors, forces on wires with currents), Transmission Lines, online demos/videos.

**Grading:** Coursework (e.g. assignments 25%, lab reports 25%)……………….…..… 50 %

Two take-home-tests ……………................................................................. 50 %

**Total ............................................................................................. 100 %**

**Grading:** Minimum percentages (subject to moderation and mitigation circumstances):

**A**: 70–100 **B**: 60–69  **C**: 50–59 **D**: 40–49 **E**: 30–39 **F**: < 30

**Learning Outcomes**

Subject Mastery: Understanding, Knowledge and Cognitive Skills

Scholarship, Enquiry and Research (Research-Informed Learning)

Personal Abilities: Industrial, Commercial and Professional Practice

Autonomy, Accountability and Working with Others

Communication, Numeracy & ICT

**Special Needs**:*Students with special needs or requiring special accommodations must contact the EPS Students Disability coordinator* [*EPSDS@hw.ac.uk*](mailto:EPSDS@hw.ac.uk) *at the earliest.*

**Honor System**: Each student is solely responsible for their submitted work. Students are encouraged to discuss in **general terms** homework solutions with classmates, but all submitted work must be their own and not plagiarized (e.g. from classmates’ homework, Internet source(s), solution manuals, past homework, etc). Failure to abide by this rule is considered plagiarism.

**Plagiarism** is an act of academic misconduct by **all parties** involved and the University will take this extremely seriously and will investigate all alleged instances. The consequences of misconduct are severe. <https://www.hw.ac.uk/students/studies/examinations/plagiarism.htm>

**Freedom in learning:** Students are responsible for learning the content of the course. Student performance shall be evaluated solely on academic basis, not on opinions or unrelated matters.

**No judgment feedback**:Students are **encouraged to provide no judgement feedback** to the instructor (e.g. in person or by email) to help improve the lectures, the course and their learning, especially early in the semester to allow time for implementation. Fairness is guaranteed by exam anonymization and TAs marking coursework.

Food / Alcoholic drinks: Not allowed in class or labs.

In-Class: Electronic devices are encouraged but must be in silent mode to not disturb others. Students are welcome to look up online information related to the course during lecture. Bring your notes, book, and calculator to every class as some quizzes may be open book/notes.

Recording any part of a lecture is *not* allowed unless the student provides a signed permission from their Disability Advisor. Recordings must be for personal use and cannot be shared.

<https://www.hw.ac.uk/students/doc/Recording_Lectures_Procedures.pdf>

<https://www.hw.ac.uk/documents/data-protection-obtaining-consent.pdf>

Disruptions: If you must be on-call for an emergency please inform the instructor before lecture.

Absences: Attendance to lectures is part of your ‘professionalism’ mark. If you miss class for unjustified reasons, you must cover on your own the taught material, so exchange contact info with a classmate. Pop-quizzes based on material recently covered in class may be given without warning. If you think your quiz, homework assignment, or other submitted work was graded incorrectly, contact the instructor or the TAs within 24 hours to check it.

#### **Assignments**. Late assignments are penalized by 10% per day; cannot be accepted after solutions have been posted. If you need to miss a class, **email** your assignment on time to a TA.

#### **Staple** your papers **(no paper clips / folded corners => zero credit).** Use **1-side** of an A4 engineering paper or plain white paper (**no spirals, no smaller sized pages**).

**How to get full credit:**

* Write/cut-n-paste/paraphrase problem description; on the left side of the page in a column write the given quantities. **Show all steps** to your solution. Include your code for plots, units, etc. “Magic” answers 🡪 no credit. (You can also copy all problems on p.1 if you wish to use a cover page).
* On **page 1** **(cover page)** write: date, course #, problem #s, name & ID#, page # (e.g. *x/y)*.
* On **each other page** write: your initials, page number (*x*/*y*).
* Include all original equations you use. Box or double underline your answers. Use practical engineering units (i.e. μF, mV, GHz etc).
* **Separate each problem with a line.** Text/figures/graphs must be **legible**. (Illegible 🡪 no credit). Plots should be titled, labeled (names, units, numbers on axes), and clear.

**To make-up for any unexpected emergencies** (illnesses, interviews, trips, family issues, flat tires, broken alarms, Nobel Prize acceptance speeches, alien abductions, etc), **the** **following grades may be dropped**:

* + the lowest quiz grade
  + the lowest homework assignment grade
  + Final Exam: You will be required to answer only 3 out of 4 Questions.

For further extraordinary circumstances, students will need to submit a Mitigating Circumstances form (<https://www.hw.ac.uk/students/studies/examinations/mitigating-circumstances.htm>) and supply the necessary documentation. The instructor should *not* be informed about the details of the MC situation. Decisions are taken by the MC committee. There will be *no make-up quizzes, labs, tutorials or exams.*

**Computer Usage:** Students will use computer simulation software (e.g. CST Microwave Studio, Keysight ADS) to study cases, geometries, analyze circuits containing current & voltage sources, etc. Students are encouraged to use computer programs for mathematics and graphing (e.g., Matlab, MS Excel. MathCad, ...).

**B38EM Introduction to Electricity and Magnetism**

**Tentative Course Schedule and Topics Covered**

|  |  |  |  |
| --- | --- | --- | --- |
| **Week** | **Class** | **Topics** | **Reading** |
| 1 |  | Welcome, Introduction, Math (Appendix: Vector Calculus, Integrals for EM) | Slides, 1.1, 1.3-1.8 |
|  | **Math**: scalars, vectors, distance, dot product, cross product | 1-1-1.8 |
|  | differentials, surface & volume integrals, flux, circulation, derivatives | 3.2-3.3, |
| 2 | 4 | Del, gradient of scalar, divergence of vector ***Tutorial 1****: Examples* | 3.4-3.6 3.7-3.8 |
| 5 | **Electrostatics**: Coulomb’s law, Elec. field Intensity **E** | 4.1-4.2 |
| 6 | Electric flux density **D**, Superposition ***Tutorial 2****: Examples* | 4.2-4.3 |
| 3 | 7 | Charge distributions, Field lines, Flux | 4.3-4.4 |
| 8 | Gauss’s law (Maxwell’s equation) | 4.5 |
| 9 | Applications of Gauss’ law ***Tutorial 3****: Examples* | 4.6 |
| 4 | 10 | Applications of Gauss’ law ***Lab 1*** | 4.6 (slides, CST) |
| 11 | Electric potential, relationship of E and V, E-field of dipole | 4.7-4.9 |
| 12 | Properties of materials, conductors, diel. & pol/tion, εr, diel.  Strength ***Tutorial 4****: Examples* | Slides (5.2,5.4-5.6) |
| 5 | 13 | **Magnetostatics:** Lorentz Force, magnetic materials**Practical examples of dielectric constant (capacitors, coax cables) Revision problems in Electrostatics (Coulomb’s law, Gauss’s law)** | 8.2, 8.5-8.6, (6.5) |
| 14 | Magnetic materials, Biot-Savart law, examples | 7.2 |
| 15 | Ampere's circuit law (Maxwell’s eqn.), Applic/ns, Examples  ***Tutorial 5****: Examples* | 7.3,7.4 |
| 6 |  | **Consolidation Week** |  |
| 7 | 16 | Ampere's circuit law (Maxwell’s eqn.), Applic/ns, Examples *Take Home Test 1* | 7.3,7.4  (CST) |
| 17 | Magnetic field intensity H, Magnetic flux density B (Maxwell’s eqn.) | 7.5 |
| 18 | Applications (inductors, inductance, intro to magnetic circuits)  ***Tutorial 7****: Examples* | 8.10 |
| 8 | 19 | **Induction**: Faraday’s law | 9.2 |
| 20 | Displacement current | 9.3, 9.4 |
| 21 | **Waves**: Maxwell’s Equations, Time-Harmonic Fields ***Tutorial 8****: Examples* | 9.5, 9.7 |
| 9 | 22 | Wave equation in lossless media (air), wave prop. | 10.2,10.5 |
| 23 | Wave power density, Poynting Vector | 10.7, 10.8 |
| 24 | Practical transmission lines: E-H / V-I, input impedance *Tut. 9: Examples* | 11.2,11.3, |
| 10 | 25 | VSWR, power, Smith Chart | 11.4,11.5 |
| 26 | **Applications of transmission lines**: coaxial cable, microstrip line | 11.8, 12.2, Notes, Pozar |
| 27 | waveguides, coplanar waveguides  ***Tutorial 10****: Examples* |  |
| 11 | 28 | Q/A Session, Revision |  |
| 29 | Q/A Session, Revision |  |
| 30 | Q/A Session, Revision |  |
| 12 | 31 | Self-study ***Take Home Test 2*** |  |
| 32 | Self-study |  |
| 33 | Self-study |  |
| 13 | 34 | ***Lab 2*** | CST or ADS |

**PREPARED BY: Dimitris Anagnostou and Yuan Ding, updated Jan. 03, 2022.**