**University of Management and Technology**

**School of Science**

***Department of Physics***

**Course Code:** **PH-**

**Course Title: Plasmas**

**Program: BS (PH)**

**Course Outline**

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| --- | --- | --- | --- | --- |
| **Schedule and Timings** | Monday-Tuesday  09:30-10:45 AM | **Pre-requisite** | A solid undergraduate background in classical physics, electromagnetic theory including Maxwell's equations, and mathematical familiarity with partial differential equations and complex analysis are prerequisites. | |
| **Course Coordinator** | Dr. Arshad Majid Mirza | **Contact** | ssc.dean@umt.edu.pk | |
| **Room No:** | Department of Physics | **Counselling Hours:** | Monday, Tuesday, Thursday  11:00 to 02:00 PM | |
| **Course**  **Description** | In this course, students will learn about plasmas, the fourth state of matter. The plasma state dominates the visible universe, and is of increasing economic importance. Plasmas behave in lots of interesting and sometimes unexpected ways. The course is intended only as a first plasma physics course, but includes critical concepts needed for a foundation for further study. This course introduces plasma phenomena relevant to energy generation by controlled thermonuclear fusion and to astrophysics, coulomb collisions and transport processes, motion of charged particles in magnetic fields, plasma confinement schemes, MHD models, simple equilibrium and stability analysis. | | | |
| **Expected**  **Outcomes** | The objective of this course is to systematically develop analytical tools for understanding plasma physics. By the end of the course, the student must be able to manipulate the fundamental elements of the plasma fluid. | | | |
| **Text**  **Book** | Chen, F. F. “Introduction to Plasma Physics and Controlled Fusion’, 3rd ed. Springer publisher, 2016.  Online ISBN 978-3-319-22309-4 | | | |
| **Reference Book:** | 1. Introduction to Plasma Physics, by R. J. Goldston and P. H. Rutherford, publisher: IoP, Bristol and Philadelphia; 1st Edition, (1995). 2. Principles of Plasma Physics, byN. A. Krall and A. W. Trivelpiece,   publisher: McGraw-Hill Book Company, New York; 1st Edition, (1973). | | | |
| **Assignments** | Problems will be assigned at regular intervals as an assignment. | **Quizzes** | | All quizzes will be announced well before time.  No make-ups will be offered for missed quizzes. |
| **Mid Term**  **Examination** | A 60-minutes exam will cover all the material covered during the first  14-16 lectures. | **Final**  **Examination** | | A 120-minutes exam will cover all the material covered during the semester. |
| **Attendance**  **Policy** | Students missing more than 20% of the lectures will receive an “SA” grade in the course and will not be allowed to take Final exam. | | | |
| **Grading**  **Policy** | Assignment+ Quizzes: 20%  Mid Term Examination: 30%  Final Examination: 50% | | | |

Department of Physics

Plasma Physics

(PH-)

**Lecture Plan**

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| --- | --- | --- | --- | --- |
| **Week** | **Lecture**  **#** | **TOPICS** | **CH** | **SECTIONS** |
| 1 | 1  2 | **Introduction**: Occurrence of plasma in Nature, Definition of Plasma,  Concept of temperature | 1  1 | 1.1, 1.2.  1.3 |
| 2 | 1  2 | Debye shielding  The plasma parameters, Criteria for plasma, Applications of plasma | 1  1 | 1.4  1.5, 1.6, 1.7 |
| 3 | 1  2 | Numerical Problems  Numerical Problems | 1  1 |  |
| 4 | 1  2 | Single-P article motions: Introduction, Uniform E and B fields (E=0)  Finite E | 2  2 | 2.1, 2.2.1  2.2.2 |
| 5 | 1  2 | Gravitational field  Numerical problems | 2  2 | 2.2.3 |
| 6 | 1  2 | Non-uniform B field  Curved B: Curvature field | 2  2 | 2.3  2.3.2 |
| 7 | 1  2 | ∇B || B: Magnetic Mirrors  Nonuniform E field | 2  2 | 2.3.3  2.4 |
| 8 | 1  2 | Time-Varying E field  Time-Varying B field | 2  2 | 2.5  2.6 |
| 9 | 1  2 | Plasmas as fluids: Introduction, Relation of plasma physics to ordinary electromagnetics  The fluid equation of motion, Equation of continuity | 3  3 | 3.1, 3.2  3.3.1, 3.3.5 |
| 10 | 1  2 | Equation of state, The complete set of fluid equations  Fluid drift perpendicular to B, Fluid drift parallel to B, The plasma approximation | 3  3 | 3.3.6, 3.3.7  3.4, 3.5 |
| 11 | 1  2 | Waves in plasma: Representation of waves, Group velocity  Plasma oscillations | 4 | 4.1, 4.2  4.3 |
| 12 | 1  2 | Electron plasma waves, Sound waves, Ion waves  Validation of plasma approximation, Comparison of ion and electron waves | 4  4 | 4.4, 4.5, 4.6  4.7,4.8 |
| 13 | 1  2 | Electrostatic electron oscillations perpendicular to B, Electrostatic ion waves perpendicular to B  The lower hybrid frequency | 4  4 | 4.9, 4.10  4.11 |
| 14 | 1  2 | Electromagnetic waves with Bo=0  Electromagnetic waves perpendicular to Bo, ordinary wave E1 || Bo, Extraordinary wave E1 ⊥ Bo | 4  4 | 4.12  4.14 |
| 15 | 1  2 | Electromagnetic waves parallel to Bo  Revision | 4 | 4.16 |