**`University of Management and Technology**



**School of Science**

***Department of Mathematics***

**Course Code:** **MTH622**

**Course Title: General Relativity-I**

**Program: MS Mathematics**

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| **Schedule** |  | **Pre-requisite** |  |
| **Course Coordinator** |  | **Contact** |  |
| **Course**  **Description** | This course introduces General Relativity with brief review of Special Relativity. Original formulation of special relativity, Poincare group and null cone structure will be discussed. The principles of General relativity will be discussed leading to Einstein field equations. Some well known exterior and interior metrics will be included in this course along with the concept of gravitational waves and linearized gravity. | | |
| **Expected**  **Outcomes** | After successfully completing the course, students should be   * Familiar with four vector formulation. * Able to understand principles of General relativity. * Able to formulate Einstein field equations and calculate components of field equations. * Understand energy-momntum tensor * Able to drive Maxwell’s equations. * Understand Birkhoff’s theorem. | | |
| **Text**  **Book(s)** | This course is research based. Latest published literature will be followed. | | |
| **Reference books/ research Papers:** | 1.    Qadir, Asghar: Relativity: An Introduction to the Special Theory (World Scientific, 1989). 2.    Stephani, Hans: General Relativity: An Introduction to the Theory of Gravitational Field (Cambridge University Press, 1990). 3.    Wald, R.M.: General Relativity (The University of Chicago Press, 1984). 4.    Misner, C.W., Thorne, K.S. and Wheeler, J.A.: Gravitation (W. H. Freeman and Co., 1973). 5.    Plebanski, J. and Krasinski, A.: An Introduction to General Relativity and Cosmology (Cambridge University Press, 2006). | | |
| **Assignments** | 4 Assignments | **Project** | 1 project from advanced topics and/or research papers |
| **Mid Term**  **Examination** | 1 Midterm Exam | **Final**  **Examination** | 1 Final Examination |
| **Attendance**  **Policy** | SA would be reported if two and half classes are missed without any accidental or medical or any extreme family matters. | | |
|  | **Grading Policy** | | |
| **Assignments** | 5- 10% | **Project** | 20-25% |
| **Mid Term**  **Examination** | 25-30% | **Final**  **Examination** | 40-50% |

**Course Outline**

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| **Sr** | **Topics to be covered:** |
| 1 | Original formulation of Special Relativity. |
| 2 | Velocity addition in 3-d formulation. |
| 3 | 4-Vector formalism. |
| 4 | Poincare group. |
| 5 | The null cone. |
| 6 | Review of Electromagnetism. |
| 7 | 4-Vector formulation of Maxwell’s equations. |
| 8 | Special Relativity with small accelerations. |
| 9 | The principles of General Relativity, The Einstein field equations. |
| 10 | The stress-energy momentum tensor. |
| 11 | The vacuum Einstein equations and the Schwarzschild solution. Birkhoff’s theorem. |
| 12 | The Reissner-Nordstrom solution and the generalized Birkhoff’s theorem. |
| 13 | The Kerr and the Kerr-Newmann solution. |
| 14 | The Newtonian limit of Relativity. |
| 15 | The Schwarzschild exterior solution and relativistic equations of motion. |
| 16 | The classical tests of Relativity and their current status. |
| 17 | The Schwarzschild interior solution. |
| 18 | Linearized gravity and gravitational waves. |