# PHY-214 Mathematical Methods of Physics I

**Credit Hours:** 3-0
**Pre-requisite:** MATH-212 Linear Algebra & ODEs

**Course Objectives:** This course comprises two parts: Ordinary differential equations and linear algebra. Physical systems are typically modelled via differential equations. This course deals with 2nd and higher order differential equations and their solutions. The linear algebra of functional basis is covered here which utilizes the solutions of special equations developed in ordinary differential equation's part.

**Core Contents:** Ordinary differential equations and complex analysis

**Detailed Course Contents:** Euler Cauchy Equations, existence and uniqueness of solution, Solution by variation of parameters, higher order differential equations, Homogenous linear ODE, Non-linear ODE with application to elastic beams, System of ODEs, Power series solution method, Legendre's equation, Extended power series method, Bessel equation, Fourier series: the Dirichlet conditions, Functions of a complex variable, Cauchy-Riemann relations, power series, elementary functions, multi-valued functions and branch cuts, singularities and zeros, Complex integrals, Cauchy's theorem and integral formula, Taylor and Laurent series, Residue theorem, definite integrals using contour integration, Contour integration.

**Course Outcomes:** At the end of the course, students will be able to

- solve linear second order differential equations
- use the power series method when exact solutions are inaccessible
- use and apply the ideas of complex variables
- learn contour integration.

**Textbook:**

Ken F. Riley, Michael P. Hobson, Stephen J. Bence, Mathematical Methods for Physics and Engineering, 3rd ed. Cambridge University Press, 2006. (Referred as RHB)

Erwin Kreyszig, Advanced Engineering Mathematics, 10th ed. John Wiley, 2011. (Referred as EK)

**Reference Books:** Peter V. O'Neil, Advanced Engineering Mathematics, 7th ed. Cengage Learning, 2011.

| Weekly Breakdown | | |
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| Week | Section | Topics |
| **1** | EK 2.5, 2.6 | Euler Cauchy Equations, existence and uniqueness of solution |
| **2** | EK 2.7, 2.8 | Non homogenous ODEs, Forced oscillations |

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| **3** | EK 2.10, 3.1 | Solution by variation of parameters, higher order differential equations |
| **4** | EK 3.2 | Homogenous linear ODE |
| **5** | EK 3.3 | Non-linear ODE with application to elastic beams |
| **6** | EK 4.1, 4.2 | System of ODEs |
| **7** | EK 5.1, 5.2 | Power series solution method, Legendre's equation |
| **8** | EK 5.3, 5.4 | Extended power series method, Bessel equation |
| | | **Midterm Exam** |
| **9** | RHB 24.1-24.3 | Functions of a complex variable, Cauchy-Riemann relations, power series, elementary functions. |
| **10** | RHB 24.5, 24.6, 24.8 | Multi-valued functions and branch cuts, singularities and zeros, Complex integrals. |
| **11** | RHB 24.9-24.10 | Cauchy's theorem and integral formula. |
| **12** | RHB 24.11 | Taylor and Laurent series |
| **13** | RHB 24.12 | Residue theorem, definite integrals using contour integration, |
| **14** | RHB 24.13 | Contour integration |
| **15** | | Revision |