INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI

<table>
<tr><td>1.</td><td>Title of the Course</td><td>Mathematical Methods for Basic Sciences I</td></tr>
<tr><td>2.</td><td>Course Number</td><td>ID5101</td></tr>
<tr><td>3.</td><td>Status of the Course</td><td>Core</td></tr>
<tr><td>4.</td><td>Structure of Credits</td><td>3 – 0 – 0 – 3</td></tr>
<tr><td>5.</td><td colspan="2">Course Objective: To introduce mathematical techniques to post-graduate/PhD students in Basic Sciences to pose, and solve, problems in Physics and Chemistry.</td></tr>
<tr><td>6.</td><td colspan="2">Course Content:
Vectors and Tensors. Applications in condensed matter, electrodynamics and astrophysics.
Linear vector spaces, Dirac notation. Basis sets, Inner Products. Orthonormality and completeness. Gram-Schmidt orthonormalization process. Linear operators, Matrix Representations, Diagonalization, Orthogonal, Hermitian and Unitary matrices.
Transcendental and Special Functions. Ordinary Differential Equations of 2^{nd} Order. Applications in Mechanics, Electrodynamics and Quantum Mechanics.
Generalized functions, Dirac delta function – Normalization of continuum eigen states.
Partial Differential Equations: Applications in Electrodynamics and Quantum Mechanics.</td></tr>
<tr><td>7.</td><td colspan="2">Text Book:
1. G. Arfken and H. J. Weber, Mathematical Methods for Physicists, 7^{th} Edition, Academic Press, Indian Edition (2012).
2. M. Boas, Mathematical Methods in Physical Sciences, 3^{rd} Edition, John Wiley, International Edition (2006).</td></tr>
<tr><td>8.</td><td colspan="2">References:
1. P. Dennerey and A. Kryzwicki, Mathematics for Physicists, Dover Publications (2005).
2. K. F. Riley, M. P. Hobson, Foundation Mathematics for the Physical Sciences, Cambridge University Press (2011).</td></tr>
</table>

INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI

1.	Title of the Course	Mathematical Methods for Basic Sciences II
2.	Course Number	ID6101
3.	Status of the Course	Elective
4.	Structure of Credits	3 – 0 – 0 – 3
5.	Course Objective: To provide a few advanced mathematical techniques to postgraduate/PhD students in Physics and Chemistry.	
6.	Course Content: Integral transforms: Laplace transforms and Fourier transforms. Applications in Spectroscopy and Quantum Mechanics. Complex functions. Cauchy-Riemann conditions. Power series. Cauchy's integral theorem. Conformal mapping. Singularities: poles, essential singularities. Residue theorem. Contour integration and examples. Analytic continuation. Multiple-valued functions, branch points and branch cut integration. Coulomb functions. Applications of the Lambert W function to solve problems in quantum mechanics. Probability theory. Probability distributions and probability densities. Standard discrete and continuous probability distributions. Moments and generating functions. Central Limit Theorem. Group theory: Elements of group theory. Molecular Point Groups. Proof of the Great Orthogonality Theorem. Character Tables. Continuous groups. Rotation groups. SO(3), SU(2) and SO(4).	
7.	Text Book: 1. G. Arfken and H. J. Weber, *Mathematical Methods for Physicists*, 7th Edition, Academic Press, Indian Edition (2012). 2. M. Boas, *Mathematical Methods in Physical Sciences*, 3rd Edition, John Wiley, International Edition (2006). 3. K. F. Riley, M. P. Hobson, *Foundation Mathematics for the Physical Sciences*, Cambridge University Press (2011).	
8.	References: 1. M. Tinkham, *Group Theory and Quantum Mechanics*, Dover (2003).	

INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI

1.	Title of the Course	Quantum Mechanics I
2.	Course Number	ID5102
3.	Status of the Course	Core
4.	Structure of Credits	3 – 0 – 0 – 3
5.	Course Objective: To provide the introduction to quantum mechanics to postgraduate/PhD students of Physics and Chemistry.	
6.	Course Content: Inadequacy of Classical Mechanics. Generalized Uncertainty Principle. Schrodinger Equation. Schrodinger, Heisenberg and Dirac Pictures of Quantum Evolution of State of a System. Angular Momentum in Quantum Mechanics. Clebsch-Gordan coefficients. Addition Theorem of Spherical Harmonics. Wigner-Eckart Theorem. Linear Harmonic Oscillator and the Hydrogen atom in Quantum Mechanics. Symmetry and Degeneracy. Time-Independent and Time-Dependent Perturbation Theory. Applications in Stark and Zeeman Spectroscopies, and in Radiative Phenomena. Fermi's Golden Rule. Time Reversal Symmetry. Inter-relationship between Collision Physics and Spectroscopy.	
7.	Text Book: 1. C. Cohen-Tannoudji, B. Diu and F. Laloe, *Quantum Mechanics*, Vol. 1 and 2, Wiley-Interscience (1977). 2. J. J. Sakurai, *Modern Quantum Mechanics*, 2nd Edition (2014).	
8.	References: 1. R. P. Feynman, R. B. Leighton and M. Sands, *The Feynman Lectures on Physics*, Vol. 3, Narosa Pub. House (1992).	

INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI

1.	Title of the Course	Quantum Mechanics II
2.	Course Number	ID6102
3.	Status of the Course	Elective
4.	Structure of Credits	3 – 0 – 0 – 3
5.	Course Objective: To provide a few advanced tools in quantum mechanics to postgraduate/PhD students in Physics and Chemistry.	
6.	Course Content: Quantum Collision Theory. Partial Wave Analysis. Angular Distributions in Scattering. Levinson's Theorem and Seaton's Theorem. Resonance states. Analysis of Breit Wigner Resonances. Fano and Generalized Fano Parametrization of Resonances. Relativistic Quantum Mechanics. Dirac Equation. Foldy-Woutheysen Transformations and interpretation of spin-orbit coupling, zitterbewegung, Darwin terms, Lamb shift. Hartree-Fock Self-Consistent Field Formalism. Koopmans Theorem. Exchange and Coulomb Correlations. Many-electron Correlations. Approximate solutions of the many-body problem. Random Phase Approximation, Density Functional Theory, Diagrammatic Perturbation Theory.	
7.	Text Book: 1. C. J. Joachain, *Quantum Collision Theory*, Elsevier Science Ltd. (1979). 2. L. D. Landau and E. M. Lifshitz, *Quantum Mechanics: Non-Relativistic Theory,* Vol. 3, 3rd Edition, Butterworth-Heinemann (1981). 3. J. D. Bjorken and S. D. Drell, *Relativistic Quantum Mechanics*, McGraw-Hill Inc. (1964). 4. S. Raimes, *Many-Electron Theory*, Elsevier Science Publishing Co. Inc. (1972).	
8.	References: 1. A. L. Fetter and J. D. Walecka*, Quantum Theory of the Many-Particle Systems*, Dover Publications (2012). 2. D. Sholl and J. A. Steckel, *Density Functional Theory –a practical introduction*, Wiley-Blackwell (2009).	

INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI

1.	Title of the Course	Fractal Geometry
2.	Course Number	MA6103
3.	Status of the Course	Elective Course
4.	Structure of Credits	3-0-0-3
5.	Course Objective: The theory of fractal geometry provides a general framework for the study of sets that had been thought to be exceptional oddities. This is an active area of research and both the theory and applications of fractal geometry are still being developed. The course is an introduction to a circle of topics in fractal geometry and chaotic dynamics.	
6.	Course Content: Classic Examples of Fractals, Metric Space, Equivalent Spaces, Classification of subsets and the Space of Fractals, Transformations on Metric Spaces, Contraction Mappings, and the Construction of Fractals Chaotic Dynamics on Fractals, Hausdorff Measure and Dimension, Alternate definitions of Dimensions and Techniques for calculating the dimension, Graphs of Functions and Fractal Interpolations, Iteration of Complex Functions: Julia Sets and Mandelbrot Sets, Measures on Fractals.	
7.	Text Book: 1. M. F. Barnsley, Fractals Everywhere – Third Edition, Dover Publications, 2012. 2. K. Falconer, Fractals Geometry: Mathematical Foundations and Applications. 3rd Edn., Wiley Publications, 1990.	
8.	References: 1. K. Falconer, The Geometry of Fractal Sets. Cambridge University Press, 1986. 2. Y. Pesin and V. Climenhaga, Lectures on Fractal Geometry and Dynamical Systems, American Mathematical Society, 2009.	

INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI

1.	Title of the Course	Linear Integral Equations
2.	Course Number	MA6101
3.	Status of the Course	Elective Course
4.	Structure of Credits	3-0-0-3
5.	Course Objective: The main objective of this course is to introduce Integral Equations, to know the relationship between Integral Equations and Differential Equations, and the methods and concepts to solve Integral Equations.	
6.	Course Content: Classification of Integral Equations; Fredholm Equations of Second Kind: Mapping Properties, Compact Operators, Adjoint Operators, Riesz Theory, Fredholm Theory; Numerics for Fredholm Equations: Degenerate Kernel Approximations, Projection Methods, Collocation Methods, Quadrature Methods; Volterra Equations;	
7.	Text Book: 1. R. Kress, Linear Integral Equations, 3rd Edn., *Springer, New York,* 2014.	
8.	References: 1.Y. Kōsaku, Lectures on Differential and Integral Equations, Translated from the Japanese. Reprint of the 1960 translation. *Dover Publications, New York,* 1991. 2. D. Porter, D. S. G. Stirling, Integral Equations: A Practical Treatment from Spectral Theory to Applications, Cambridge University Press, 1990. 3. W. V. Lovitt, Linear Integral Equations. Dover Publications, New York, 1950.	

INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI

1.	Title of the Course	Fixed Point Theory
2.	Course Number	MA6102
3.	Status of the Course	Elective
4.	Structure of Credits	3-0-0-3
5.	Course Content: (Max 100 words) Contraction Principle, and its variants and applications; Fixed points of nonexpansive maps and set valued maps, Brouwer -Schauder fixed point theorems, Ky Fan Best Approximation Theorem, Principle and Applications of KKM -maps, their variants and applications. Fixed Point Theorems in partially ordered spaces and other abstract spaces. Application of fixed point theory to Game theory and Mathematical Economics.	
6.	Text Book: 1. M.A.Khamsi and W.A.Kirk, An introduction to Metric Spaces and Fixed Point Theory, Wiley - Inter Sci., New York, 2001.	
7.	References: 1. W. A. Kirk and B. Sims, Hand Book of Metric Fixed Point Theory, Springer, Netherlands, 2001. 2. K. C. Border, Fixed point theorems with applications to economics and game theory, Cambridge University Press, Cambridge, 1985. 3. S. Singh, B. Watson and P. Srivastava, Fixed Point Theory and Best Approximation: The KKM - map Principle, Kluwer Academic Publishers, Dordrecht, 1997.	

INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI

1.	Title of the Course	Mathematics for Engineers
2.	Course Number	MA5101
3.	Status of the Course	Elective
4.	Structure of Credits	3-0-0-3
5.	Course Objective: (Max 70 words) To study some properties of matrices, diagonalization of matrices, the power series solutions to second order differential equations, Sturm-Liouville problem, wave and heat equations in 1-dim and 2-dim and also to study Laplace's equations in 2-dim and 3-dim.	
6.	Course Content: (Max 100 words) 1. System of linear equations, linear dependence, linear independence, inner product spaces, Gram-Schmidt orthogonalization, eigen values, eigen vectors, diagonalization of symmetric and Hermitian matrices. 2. Linear equations, variation of constants formula, Sturm-Liouville boundary value problems, Power Series solutions, Legendre and Bessel's functions, Fourier series and Fourier integrals. 3. 1-D and 2-D Wave (including D'Alembert solution) and Heat equations with initial and Boundary conditions, 2-D and 3-D Laplace's equations with circular and Spherical symmetry.	
7.	Text Book: 1. E. Kreyszig, Advanced Engineering Mathematics, 10^{th} Edn., John Willey & Sons, 2010.	
8.	References: 1. T. Amarnath, An Elementary Course in Partial Differential Equations, Jones & Bartlett Learning, 2009. 2. C. R. Wylie, Advanced Engineering Mathematics, 6^{th} Edn., McGraw-Hill Higher Education, 1995.	