MATHEMATICS COMPLEMENTARY ELECTIVE COURSES FOR BSc PHYSICS PROGRAMME

COMPLEMENTARY ELECTIVE COURSE 1:

MATHEMATICS FOR PHYSICS I

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
I	**1C01 MAT - PH**	**4**	**3**	**3**	**40**	**10**	**50**

COURSE OUTCOMES

CO1	Understand the concept of Differentiation and successive differentiation.
CO2	Understand Fundamental theorem – Rolle's theorem, Lagrange's mean-value theorem, Cauchy's mean-value theorem,.
CO3	Understand the Taylor's theorem , expansions of functions – Maclaurin's series, expansion by use of known series
CO4	Understand the Matrices and System of Equations, Linear Transformations
CO5	Understand Rank of a matrix, elementary transformations, normal form of a matrix, inverse of a matrix, solution of linear system of equations.
CO6	Understand Linear transformations, orthogonal transformation, vectors – linear dependence
CO7	Understand Derivative of arc, curvature, Polar coordinates, Cylindrical and Spherical co-ordinates

1C01 MAT-PH: Mathematics for Physics I

Unit I - Differential Calculus - Differentiation and successive differentiation (18 hours)

Text: Differential Calculus, Shanti Narayan and P. K. Mittal

Quick review of basics of differentiation – Derivatives of standard functions, rules of differentiation, parametric differentiation. (*Questions should not be asked in the End Semester Examinations from the above sections for quick review*) (Relevant portions from sections 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10).

Text: Higher Engineering Mathematics (41^{st} edition), B.S. Grewal, Khanna Pub.

Successive differentiation, standard results, preliminary transformations, use of partial fractions, Leibnitz's theorem for the nth derivative of the product of two functions (Sections 4.1, 4.2)

Unit II - Differential Calculus – Applications of differential Calculus (18 hours)

Text: Higher Engineering Mathematics (41^{st} edition), B.S. Grewal, Khanna Pub.

Fundamental theorem – Rolle's theorem, Lagrange's mean-value theorem, Cauchy's mean-value theorem, Taylor's theorem (Generalised mean value theorem)(without proof), expansions of functions – Maclaurin's series, expansion by use of known series, Taylor's series, Indeterminate forms - form 0/0, form ∞/∞, form reducible to 0/0 form - form $0.\infty$, form $\infty-\infty$, forms $0^0, 1^\infty, \infty^0$. (Sections 4.3, 4.4, 4.5)

Unit III - Linear Algebra – Matrices and System of Equations, Linear Transformations (20 hours)

Text: Higher Engineering Mathematics (41^{st} edition), B.S. Grewal, Khanna Pub.

Rank of a matrix, elementary transformation of a matrix, equivalent matrix,s elementary matrices, Gauss-Jordan method of finding the inverse, normal form of a matrix, partition method of finding the inverse, solution of linear system of equations – method of determinants – Cramer's rule, matrix inversion method, consistency of linear system of equations, Rouche's theorem, procedure to test the consistency of a system of equations in n unknowns, system of linear homogeneous equations. Linear transformations, orthogonal transformation, vectors – linear dependence

(Sections 2.7, 2.8, 2.9, 2.10, 2.11, 2.12)

Unit IV - Curvature and Geometry **(16 hours)**

Text: Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.

Derivative of arc, curvature (radius of curvature only for Cartesian curve y=f(x)), centre of curvature

(Sections 4.9, 4.10, 4.11, 4.12)

Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services.

Polar coordinates, Cylindrical and spherical co-ordinates

(Section 11.3, relevant portions from section 15.7).

References

1. Differential and Integral Calculus, S. Narayanan and T.K.M. Pillay, S. Viswanathan Printers and Publishers, Chennai.
2. Text of Matrices, Shanti Narayan and P.K. Mittal, S. Chand & Co.
3. Theory of and Problems of Matrices, Frank Ayres JR, Schaum's Outline Series, McGraw- Hill Book Company.
4. Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley.
5. Calculus (10th edition), Anton, Bivens, Davis, Wiley-India.

Marks including choice

Unit	**Marks in End Semester Examination**	
	Aggregate Marks	**Maximum Marks**
I	18	**40**
II	16	
III	18	
IV	14	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (11 questions x Marks 2 each = 22)

- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 28)

- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)

- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVE COURSE 2:

MATHEMATICS FOR PHYSICS II

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
II	2C02 MAT - PH	4	3	3	40	10	50

COURSE OUTCOMES

CO1	Understand partial derivatives, homogeneous functions, Euler's theorem, total derivative, differentiation of implicit functions, change of variables
CO2	Understand Integration and Integration by Successive Reduction , Integration of Trigonometric Functions
CO3	Comprehend Applications of Integration
CO4	Comprehend Eigen values, Eigen vectors, properties of Eigen values,
CO5	Understand Cayley- Hamilton theorem, Diagonal form, similarity of matrices, powers of a matrix, canonical form, nature of a quadratic form

2C02 MAT-PH: Mathematics for Physics II

Unit I - Differential Calculus – Partial Differentiation (18 hours)
Text: Differential Calculus, Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.
Functions of two or more variables, limits, continuity, partial derivatives, homogeneous functions, Euler's theorem on homogeneous functions, total derivative, differentiation of implicit functions, change of variables.
(Sections 5.1, 5.2, 5.4, 5.5, 5.6)

Unit II - Integral Calculus - Integration and Integration by Successive Reduction (18 hours)
Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services.
Quick review of basics of Integration (*Questions should not be asked in the End Semester Examinations from the above sections for quick review*)
(Sections 8.1, 8.2, 8.3, 8.4, 8.5)
Text: Integral Calculus, Santhi Narayanan and P.K. Mittal
Integration of Trigonometric Functions: Integration of $\sin^n x$ where n is a positive integer, Integration of $sin^n x,$ evaluation of the definite integral $\int_0^{\frac{\pi}{2}} sin^n x\, dx$, Integration of $cos^n x$, evaluation of the definite integral $\int_0^{\frac{\pi}{2}} cos^n x\, dx$, Integration of $sin^p x cos^q x$, evaluation of the definite integral $\int_0^{\frac{\pi}{2}} sin^p x\, cos^q x dx$, integration of $tan^n x$, integration of $cot^n x$, integration of $sec^n x$, integration of $cosec^n x$
(Sections 4.1, 4.1.1, 4.2, 4.2.1, 4.3, 4.3.1, 4.4.1, 4.4.2, 4.5.1, 4.5.2)

Unit III - Integral Calculus – Applications of Integration (18 hours)
Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services.
Substitutions and the area between curves, volumes using cross sections, arc length, areas of surfaces of revolution, areas and length in polar coordinates
(Section 5.6, 6.1, 6.3, 6.4, 11.5)

Unit IV - Linear Algebra – Eigen Values and Cayley Hamilton Theorem (18 hours)
Text: Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.
Eigen values, eigen vectors, properties of eigen values, Cayley- Hamilton theorem (without proof), reduction to diagonal form, similarity of matrices,

powers of a matrix, reduction of quadratic form to canonical form, nature of a quadratic form.
(Sections 2.13, 2.14, 2.15, 2.16, 2.17, 2.18).

References

1. Differential and Integral Calculus, S. Narayanan and T.K.M. Pillay, S. Viswanathan Printers and Publishers, Chennai.
2. Text of Matrices, Shanti Narayan and P.K. Mittal, S. Chand & Co.
3. Theory of and Problems of Matrices, Frank Ayres JR, Schaum's Outline Series, McGraw- Hill Book Company.
4. Advanced Engineering Mathematics (10^{th} edition), E. Kreyszig, Wiley.
5. Calculus (10^{th} edition), Anton, Bivens, Davis, Wiley-India

Marks including choice

<table>
<tr><th rowspan="2">Unit</th><th colspan="2">Marks in End Semester Examination</th></tr>
<tr><th>Aggregate Marks</th><th>Maximum Marks</th></tr>
<tr><td>I</td><td>16</td><td rowspan="5">40</td></tr>
<tr><td>II</td><td>16</td></tr>
<tr><td>III</td><td>16</td></tr>
<tr><td>IV</td><td>18</td></tr>
<tr><td>Total</td><td>66</td></tr>
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Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)
- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (11 questions x Marks 2 each = 22)
- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 28)
- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)
- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVE COURSE 3:

MATHEMATICS FOR PHYSICS III

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
III	3C03 MAT - PH	5	3	3	40	10	50

COURSE OUTCOMES

CO1	Understand the concept of Multiple Integrals and solves problems
CO2	Understand Vector Differentiation
CO3	Understand Laplace Transforms and its Applications
CO4	Understand Fourier Series and Half range expansions

3C03 MAT-PH: Mathematics for Physics III

Unit I - Integral Calculus – Multiple Integrals (26 hours)
Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services.

Double and Iterated Integrals over rectangles, double integrals over general regions, area by double integration, double integrals in polar form, triple integrals in rectangular co-ordinates, substitutions in multiple integrals
(Sections 15.1, 15.2, 15.3, 15.4, 15.5, 15.8)

Unit II - Vector Calculus – Vector Differentiation (22 hours)
Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services.

Lines and planes in space, curves in space and their tangents, curvature and normal vector of a curve, tangential and normal components of acceleration, directional derivatives and gradient vectors.
(Sections 12.5, 13.1, 13.3 to 13.5, 14.5)

Unit III - Laplace Transforms and its Applications **(24 hours)**

Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley.

Laplace Transforms: Laplace Transform, Linearity, first shifting theorem (*s*-Shifting), Transforms of Derivatives and Integrals, ODEs, Unit step Function, second shifting theorem (*t*- Shifting), Convolution, Integral Equations, Differentiation and integration of Transforms, special linear ODE's with variable coefficients, Systems of ODEs, Laplace Transform, General Formulas, Table of Laplace Transforms.

(Chapter 6 Sections 6.1, 6.2, 6.3, 6.5, 6.6, 6.7, 6.8, 6.9)(Proofs are omitted)

Unit IV - Fourier Series **(18 hours)**

Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley.

Fourier Series Fourier series, arbitrary period, , Even and Odd functions, Half-range Expansions. (Proofs are omitted)

(Chapter 11 Sections 11.1, 11.2)

References

1. Introduction to Vector Analysis, H. F. Davis and Arthur David Snider, Universal Book Stall, New Delhi.
2. Vector Analysis, M. R. Spiegel, Schaum's Outline Series, Asian Student edition
3. Vector Calculus, F.W. Bedford and T.D. Dwivedi, McGraw Hill.
4. Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.

Marks including choice

Unit	**Marks in End Semester Examination**	
	Aggregate Marks	**Maximum Marks**
I	18	**40**
II	16	
III	18	
IV	14	
Total	**66**	

Pattern of Question Paper

Part A -	**Short answer**	(5 questions x Mark 1each = 5)
	• ***Answer any 4 questions***	(4 *questions x Mark 1each = 4*)
Part B -	**Short Essay**	(11 questions x Marks 2 each = 22)
	• ***Answer any 7 questions***	*(7 questions x Marks 2 each=14)*
Part C -	Essay	(7 questions x Marks 3 each = 28)
	• ***Answer any 4 questions***	*(4 questions x Marks 3 each=12)*
Part D -	**Long Essay**	(4 questions x Marks 5 each = 20)
	• ***Answer any 2 questions***	*(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVE COURSE 4:
MATHEMATICS FOR PHYSICS IV

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
IV	4C04 MAT - PH	5	3	3	40	10	50

COURSE OUTCOMES

CO1	Understand Wave Equation, Solution by Separating Variables, D-Alembert's solution of the wave equation.
CO2	Understand Heat Equation and Solution by Fourier Series
CO3	Understand Line integrals , path independence, conservative fields and potential functions, Green's theorem in the plane
CO4	Understand Surface area, surface integrals, Stoke's theorem, Divergence theorem
CO5	Understand Numerical Integration, Trapezoidal Rule, Simpson's 1/3-Rule
CO6	Understand Numerical Solutions of Ordinary Differential Equations by Taylor's series, Euler's method, Modified Euler's method, Runge-Kutta methods.

4C04 MAT-PH: Mathematics for Physics IV

Unit I - Partial differential Equations (20 hours)
Text: Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley.
Basic Concepts, Modeling: Vibrating String, Wave Equation,
Solution by Separating Variables, Use of Fourier Series, D-Alembert's solution of the wave equation, Heat Equation, Solution by Fourier Series.
(Chapter 12 sections 12.1, 12.2, 12.3, 12.4, 12.5, 12.6)
(*Excluding* steady two dimensional heat problems and Laplace equation of 12.5).

Unit II - Vector Calculus – Vector Integration (22 hours)
Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services.
Line integrals (mass, moment and moment of inertia are excluded), vector fields and line integrals: work, circulation and flux, path independence, conservative fields and potential functions, Green's theorem in the plane (Proof of Green's theorem is excluded)
(Sections 16.1, 16.2,16.3,16.4)

Unit III - Vector Calculus – Vector Integration (24 hours)
Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services.
Surfaces and area, surface integrals, Stoke's theorem, the divergence theorem and unified theory (Gauss's Law: One of the four great laws of Electromagnetic Theory, continuity equation of Hydrodynamics, Unifying the integral theorems are excluded) (Proofs of all theorems are excluded)
(Sections16.5, 16.6, 16.7, 16.8)

Unit IV - Numerical Analysis (24 hours)
Text: Introductory Methods of Numerical Analysis (fifth edition), S.S. Sastry PHI Learning.
Numerical Integration: Numerical Integration, Trapezoidal Rule, Simpson's 1/3- Rule
(Chapter 6 Sections 6.4, 6.4.1, 6.4.2)
Numerical Solutions of Ordinary Differential Equations: Introduction, Solution by Taylor's series, Euler's method, Modified Euler's method, Runge-Kutta methods.
(Sections 8.1, 8.2, 8.4, 8.4.2, 8.5)

References

1. Introduction to Vector Analysis, H. F. Davis and Arthur David Snider, Universal Book Stall, New Delhi.
2. Vector Analysis, M. R. Spiegel, Schaum's Outline Series, Asian Student edition
3. Vector Calculus, F.W. Bedford and T.D. Dwivedi, McGraw Hill.
4. Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.
5. Mathematical methods, S. R. K. Iyengar and R. K. Jain, Narosa Pub.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	16	**40**
II	16	
III	16	
IV	18	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (11 questions x Marks 2 each = 22)

- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 28)

- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)

- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

MATHEMATICS COMPLEMENTARY ELECTIVE COURSES FOR BSc CHEMISTRY PROGRAMME

COMPLEMENTARY ELECTIVE COURSE 1:

MATHEMATICS FOR CHEMISTRY I

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
I	1C01 MAT-CH	4	3	3	40	10	50

Course outcomes

CO1	Understand Successive differentiation and Leibnitz's theorem for the nth derivative of the product of two functions
CO2	Understand Fundamental theorem – Rolle's theorem, Lagrange's mean-value theorem and Cauchy's mean value theorem.
CO3	Understand Taylor's theorem, expansions of functions – Maclaurin's series, expansion by use of known series and Taylor's series.
CO4	Understand the method of finding limits of Indeterminate forms.
CO5	Understand Polar, Cylindrical and Spherical co-ordinates.
CO6	Understand Rank of a matrix, elementary transformation of a matrix, equivalent matrices, elementary matrices, Gauss-Jordan method of finding the inverse, normal form of a matrix and partition method of finding the inverse.
CO7	Understand solution of linear system of equations – method of determinants – Cramer's rule, matrix inversion method, consistency of linear system of equations, Rouche's theorem, procedure to test the consistency of a system of equations in n unknowns, system of linear homogeneous equations.
CO8	Understand Linear transformations, orthogonal transformation and linear dependence of vectors.
CO9	Understand methods of curve fitting, graphical method, laws reducible to the linear law, principles of least squares, method of least squares and apply the principle of least squares to fit the straight line $y=a+bx$, to fit the parabola $y=a+bx+cx^2$, to fit $y=ax^b$, $y=ae^{bx}$ and $xy^n=b$

1C01 MAT-CH: Mathematics For Chemistry I

Unit I - Differential Calculus - Differentiation and successive differentiation (18 hrs)
Text: Differential Calculus, Shanti Narayan and P.K. Mittal
Quick review of basics of differentiation – Derivatives of standard functions, rules of differentiation, parametric differentiation. *(Questions should **not** be asked in the End Semester Examinations from the above sections for quick review)* (Relevant portions from sections 4.3,4.4,4.5,4.6,4.7, 4.8,4.9,4.10)

Text: Higher Engineering Mathemaics (41^{st} edition), B.S. Grewal, Khanna Pub.
Successive differentiation, standard results, preliminary transformations, use of partial fractions, Leibnitz's theorem for the nth derivative of the product of two functions (Sections 4.1, 4.2)

UnitII : Differential Calculus – Applications of Differentiation (18 hrs)
Text: Higher Engineering Mathematics (41^{st} edition), B.S. Grewal, Khanna Pub.
Fundamental theorem – Rolle's theorem, Lagrange's mean-value theorem, Cauchy's mean-value theorem, Taylor's theorem (Generalised mean value theorem)(without proof), expansions of functions – Maclaurin's series, expansion by use of known series, Taylor's series, Indeterminate forms - form 0/0, form ∞/∞, forms reducible to 0/0 form - form $0.\infty$, form $\infty-\infty$, forms $0^0, 1^\infty, \infty^0$.

Unit III Linear Algebra – Matrices and System of Equations, Linear Transformations (20 hrs)
Text: Higher Engineering Mathematics (41^{st} edition), B.S. Grewal, Khanna Pub.
Rank of a matrix, elementary transformation of a matrix, equivalent matrix,s elementary matrices, Gauss-Jordan method of finding the inverse, normal form of a matrix, partition method of finding the inverse, solution of linear system of equations – method of determinants – Cramer's rule, matrix inversion method, consistency of linear system of equations, Rouche's theorem, procedure to test the consistency of a system of equatios in n unknowns, system of linear homogeneous equations. Linear transformations, orthogonal transformation, vectors – linear dependence
(Sections 2.7, 2.8, 2.9, 2.10, 2.11, 2.12)

Unit IV Curve Fitting **(16 hrs)**

Text: Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.

Introduction, graphical method, laws reducible to the linear law, principles of least squares, method of least squares, to fit the straight line y=a+bx, to fit the parabola $y=a+bx+cx^2$ (Sections 24.1, 24.2, 24.3, 24.4, 24.5)

References

1. Differential and Integral Calculus, S. Narayanan and T.K.M. Pillay, S. Viswanathan Printers and Publishers, Chennai
2. Text of Matrices, Shanti Narayan and P.K. Mittal, S. Chand & Co.
3. Theory of and Problems of Matrices, Frank Ayres JR, Schaum's Outline Series, McGraw- Hill Book Company
4. Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley
5. Calculus (10th edition), Anton, Bivens, Davis, Wiley-India
6. Fundamentals of Mathematical Statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	Maximum Marks
I	16	**40**
II	16	
III	20	
IV	14	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)

- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 21)

- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)

- ***Answer any 1 question*** *(2 questions x Marks 5each=10).*

COMPLEMENTARY ELECTIVE COURSE 2:
MATHEMATICS FOR CHEMISTRY II

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
II	2C02 MAT-CH	4	3	3	40	10	50

COURSE OUTCOMES

CO1	Understand Functions of two or more variables, limits and continuity.
CO2	Understand partial derivatives, homogeneous functions, Euler's theorem on homogeneous functions, total derivative, differentiation of implicit functions and change of variables.
CO3	Understand Reduction formulae for trigonometric functions and evaluation of definite integrals $\int_0^{\frac{\pi}{2}} sin^n x\, dx$, $\int_0^{\frac{\pi}{2}} cos^n x\, dx$ and $\int_0^{\frac{\pi}{2}} sin^p x\, cos^q x dx$.
CO4	Understand Substitutions and the area between curves, arc length, areas and length in polar coordinates.
CO5	Understand Double and Iterated Integrals over rectangles, double integrals over general regions, area by double integration, double integrals in polar form and triple integrals in rectangular co-ordinates.
CO6	Understand Eigen values, Eigen vectors, properties of Eigen values, Cayley- Hamilton theorem, reduction to diagonal form, similarity of matrices, powers of a matrix, reduction of quadratic form to canonical form and nature of a quadratic form

2C02 MAT-CH: Mathematics for Chemistry II

Unit I - Differential Calculus – Partial Differentiation (18 hours)
Text: Differential Calculus, Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.
Functions of two or more variables, limits, continuity, partial derivatives, homogeneous functions, Euler's theorem on homogeneous functions, total derivative, differentiation of implicit functions, change of variables.
(Sections 5.1, 5.2, 5.4, 5.5, 5.6)

Unit II - Integral Calculus - Integration and Integration by Successive Reduction (18 hours)
Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services
Quick review of basics of Integration **(Questions should not be asked in the End Semester Examinations from the above sections for quick review)**
(Sections 8.1, 8.2, 8.3, 8.4, 8.5)

Text: Integral Calculus, Santhi Narayanan and P.K. Mittal
Integration of Trigonometric Functions: Integration of $\sin^n x$ where n is a positive integer, Integration of $sin^n x,$ evaluation of the definite integral $\int_0^{\frac{\pi}{2}} sin^n x\, dx$, Integration of $cos^n x$, evaluation of the definite integral $\int_0^{\frac{\pi}{2}} cos^n x\, dx$,Integration of $sin^p x cos^q x,$ evaluation of the definite integral $\int_0^{\frac{\pi}{2}} sin^p x\, cos^q x dx$, integration of $tan^n x$, integration of $cot^n x$, integration of $sec^n x$, integration of $cosec^n x$
(Sections 4.1, 4.1.1, 4.2, 4.2.1, 4.3, 4.3.1, 4.4.1, 4.4.2, 4.5.1, 4.5.2)

Unit III - Integral Calculus – Applications of Integration and Multiple Integrals (20 hours)
Text: Thomas' Calculus (12th edition), Maurice D. Weir and Joel Hass, Pearson India Education Services.
Substitutions and the area between curves, arc length, polar coordinates, areas of surfaces of revolution, areas and length in polar coordinates (Section 5.6, 6.3, 11.3, 11.5).

Double and Iterated Integrals over rectangles, double integrals over general regions, area by double integration, double integrals in polar form, triple integrals in rectangular co-ordinates (Sections 15.1, 15.2, 15.3, 15.4, 15.5).

Unit IV - Linear Algebra – Eigen Values **(16 hours)**

Text: Higher Engineering Mathematics (41st edition), B.S. Grewal, Khanna Pub.

Eigen values, eigen vectors, properties of eigen values, Cayley- Hamilton theorem (without proof), reduction to diagonal form, similarity of matrices, powers of a matrix, reduction of quadratic form to canonical form, nature of a quadratic form (Sections 2.13, 2.14, 2.15, 2.16, 2.17, 2.18.)

References

1. Differential and Integral Calculus, S. Narayanan and T.K.M. Pillay, S. Viswanathan Printers and Publishers, Chennai
2. Text of Matrices, Shanti Narayan and P.K. Mittal, S. Chand & Co.
3. Theory of and Problems of Matrices, Frank Ayres JR, Schaum's Outline Series, McGraw- Hill Book Company
4. Advanced Engineering Mathematics (10th edition), E. Kreyszig, Wiley
5. Calculus (10th edition), Anton, Bivens, Davis, Wiley-India

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	Maximum Marks
I	16	**40**
II	16	
III	20	
IV	14	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)

- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 21)

- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)

Answer any 2 questions *(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVE COURSE 3:

MATHEMATICS FOR CHEMISTRY III

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
III	3C03 MAT-CH	5	3	3	40	10	50

COURSE OUTCOMES

CO1	Understand Ordinary differential equations, Geometrical meaning of $y' = f(x, y)$ and Direction Fields.
CO2	Understand Methods of solving Differential Equations: Separable ODEs, Exact ODEs, Integrating Factors, Linear ODEs and Bernoulli Equation.
CO3	Understand Orthogonal Trajectories, Existence and Uniqueness of Solutions.
CO4	Understand Second order ODEs, Homogeneous Linear ODEs of second order, Homogeneous Linear ODEs with constant coefficients, Differential Operators, Euler-Cauchy Equation, Existence and Uniqueness of Solutions – Wronskian, Nonhomogeneous ODEs and Solution by variation of Parameters
CO5	Understand Laplace Transform, Linearity, first shifting theorem, Transforms of Derivatives and Integrals, ODEs, Unit step Function, second shifting theorem, Convolution, Integral Equations, Differentiation and integration of Transforms and to solve special linear ODE's with variable coefficients and Systems of ODEs
CO6	Understand Fourier series, arbitrary period, Even and Odd functions, Half-range Expansions.

3CO3 MAT-CH: Mathematics for Chemistry III

Unit I - First Order Ordinary Differential Equations (25 hrs)
Text: Advanced Engineering Mathematics (10^{th} edition), E. Kreyszig.
Basic concepts, Geometrical meaning of $y' = f(x, y)$. Direction Fields (numerical method by Euler is excluded), Separable ODEs (modelling is excluded) , Exact ODEs, Integrating Factors, Linear ODEs, Bernoulli Equation (population dynamics is excluded).
(Sections 1.1, 1.2, 1.3, 1.4, 1.5)

Unit II: Second Order Ordinary Differential Equations (20 hrs)
Text: Advanced Engineering Mathematics (10^{th} edition), E. Kreyszig, Wiley.
Homogeneous Linear ODEs of second order, Homogeneous Linear ODEs with constant coefficients, Differential Operators, Euler-Cauchy Equation, Existence and Uniqueness of Solutions – Wronskian (statement of Theorems only, proofs omitted), Nonhomogeneous ODEs, Solution by variation of Parameters.
(Sections 2.1 to 2.10 *except* 2.4, 2.8 and 2.9)

Unit III: Laplace Transforms and its Applications (25 hrs)
Text: Advanced Engineering Mathematics (10^{th} edition), E. Kreyszig, Wiley.
Laplace Transform, Linearity, first shifting theorem (*s*-Shifting), Transforms of Derivatives and Integrals, ODEs, Unit step Function, second shifting theorem (*t*- Shifting), Convolution, Integral Equations, Differentiation and integration of Transforms, special linear ODE's with variable coefficients, Systems of ODEs, Laplace Transform, General Formulas, Table of Laplace Transforms.
(Sections 6.1, 6.2, 6.3, 6.5, 6.6, 6.7, 6.8, 6.9 (Proofs are omitted))

Unit IV Fourier Series (20 hrs)
Text: Advanced Engineering Mathematics (10^{th} edition), E. Kreyszig, Wiley.
Fourier series, arbitrary period, Even and Odd functions, Half-range Expansions. (Proofs are omitted)
(Sections 11.1, 11.2)

References

1. Higher Engineering Mathematics (41^{st} edition), B .S. Grewal, Khanna Pub.

2. Elementary Differential Equations and Boundary Value Problems, W.E. Boyce and R.C. Deprima, Wiley
3. Differential Equations, S.L. Ross, Wiley
4. An Introduction to Ordinary Differential Equtions, E.A. Coddington, Printice Hall
5. A Text of Engineering Mathematics, N.P. Bali and Manish Goyal, Laxmi Pub.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	Maximum Marks
I	19	**40**
II	16	
III	18	
IV	13	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)

- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 21)

- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)

- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*

COMPLEMENTARY ELECTIVE COURSE 4:

MATHEMATICS FOR CHEMISTRY IV

SEMESTER	COURSE CODE	HOURS PER WEEK	CREDIT	EXAM HOURS	MARKS		
					END SEM EXAM	INTERNAL	TOTAL
IV	4C04 MAT-CH	5	3	3	40	10	50

COURSE OUTCOMES

CO1	Understand Partial Differential Equations, Modeling, Vibrating String, Wave Equation..
CO2	Solve PDE by Separating Variables, by use of Fourier Series, D-Alembert's solution of the wave equation and Heat Equation.
CO3	Understand Numerical Integration, Trapezoidal Rule, Simpson's 1/3-Rule
CO4	Understand Numerical methods to find Solutions of Ordinary Differential Equations: Solution by Taylor's series, Euler's method, Modified Euler's method, Runge-Kutta methods.
CO5	Understand volumes of solid using cross sections and areas of surfaces of revolution

4C04 MAT-CH: Mathematics for Chemistry IV

Unit I - Partial differential Equations (30 hrs)
Text: Advanced Engineering Mathematics (10^{th} edition), E. Kreyszig, Wiley.
Basic Concepts, Modeling: Vibrating String, Wave Equation, Solution by Separating Variables, Use of Fourier Series, D-Alembert's solution of the wave equation, Heat Equation, Solution by Fourier Series.
(sections 12.1, 12.2, 12.3, 12.4, 12.5, 12.6) (*Excluding* steady two dimensional heat problems and Laplace equation of 12.5).

Unit II - Numerical Analysis (30 hrs)
Text: Introductory Methods of Numerical Analysis (fifth edition), S.S. Sastry, PHI Learning
Numerical Integration - Trapezoidal Rule, Simpson's 1/3-Rule
(Sections 6.4, 6.4.1, 6.4.2)
Numerical Solutions of Ordinary Differential Equations: Introduction, Solution by Taylor's series, Euler's method, Modified Euler's method, Runge-Kutta methods.
(Sections 8.1, 8.2, 8.4, 8.4.2, 8.5)

Unit III - Group Theory
Text: Group Theory in Chemistry, M.S. Gopinathan and V. Ramakrishnan, Vishal Pub. Co. (30 hrs)
Symmetry elements and symmetry operations: Identity, rotation, reflection, improper rotation and inversion.
Group theory - Definition of group, order of a group, classes and similarity transformations, point group classifications, subgroups- group multiplication table. Matrix representation of symmetry operations – rotation, reflection, identity.
(Sections 1.1, 1.2, 2.1, 2.2, 2.3, 3.1, 3.2).

References

1. Higher Engineering Mathematics (41^{st} edition), B .S. Grewal, Khanna Pub.
2. Mathematical methods, S. R. K. Iyengar and R. K. Jain, Narosa Pub.
3. Molecular Symmetry and Group Theory, Robert L. Carter, Wiley.
4. Chemical Applications of Group Theory (3^{rd} edition), F. Albert Cotton, Wiley

5. Group Theory and Symmetry in Chemistry, Gurudeep Raj, Ajay Bhagi and Vinod Jain, Krishna Prakashan Media.

Marks including choice

Unit	Marks in End Semester Examination	
	Aggregate Marks	**Maximum Marks**
I	22	**40**
II	22	
III	22	
Total	**66**	

Pattern of Question Paper

Part A - **Short answer** (5 questions x Mark 1each = 5)

- ***Answer any 4 questions*** (4 *questions x Mark 1each = 4*)

Part B - **Short Essay** (10 questions x Marks 2 each = 20)

- ***Answer any 7 questions*** *(7 questions x Marks 2 each=14)*

Part C - **Essay** (7 questions x Marks 3 each = 21)

- ***Answer any 4 questions*** *(4 questions x Marks 3 each=12)*

Part D - **Long Essay** (4 questions x Marks 5 each = 20)

- ***Answer any 2 questions*** *(2 questions x Marks 5 each=10).*