# DON BOSCO ARTS & SCIENCE COLLEGE

## ANGADIKADAVU

*(Affiliated to Kannur University Approved by Government of Kerala)*

**ANGADIKADAVU P.O., IRITTY, KANNUR – 670706**

# COURSE PLAN

# BSC MATHEMATICS

**(2019 – 22)**

# SEMESTER – VI

# ACADEMIC YEAR - (2021-22)

| VI Semester BSC MATHEMATICS (2019 - 22) | | | |
|---|---|---|---|
| SL. No. | Name of Subjects with Code | Name of the Teacher | Duty Hours per week |
| 1. | 6B10 MAT Real Analysis II | Anil M V | 6 |
| 2. | 6B11 MAT Complex Analysis | Ajeena Joseph | 6 |
| 3. | 6B12 MAT Numerical Methods, Fourier Series and Partial Differential Equations | Athulya P | 6 |
| 4. | 6B13 MAT Linear Algebra | Prija V | 6 |
| 5. | 6B14B MAT Operations Research | Riya Baby+Ajeena Joseph+Prija V. | 6 |
| | Name of Class Incharge | Riya Baby | |

## TIME TABLE

| Day | 09.50 Am - 10.45 Am | 10.45 Am -11.40 Am | 11.55 Am -12.50 Pm | 01.40 Pm - 02.35 Pm | 02.35 Pm - 03.30 Pm |
|---|---|---|---|---|---|
| 1 | 6B14B MAT Operations Research | 6B12 MAT Numerical Methods, Fourier Series and Partial Differential Equations | 6B13 MAT Linear Algebra | 6B10 MAT Real Analysis II | 6B11 MAT Complex Analysis |
| 2 | 6B12 MAT Numerical Methods, Fourier Series and Partial Differential Equations | 6B11 MAT Complex Analysis | 6B10 MAT Real Analysis II | 6B14B MAT Operations Research | 6B13 MAT Linear Algebra |
| 3 | 6B11 MAT Complex Analysis | 6B10 MAT Real Analysis II | 6B12 MAT Numerical Methods,Fourier Series and Partial Differential Equations | 6B13 MAT Linear Algebra | 6B14B MAT Operations Research |

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|---|---|---|---|---|---|
| 4 | **6B10 MAT Real Analysis II** | **6B13 MAT Linear Algebra** | **6B11 MAT Complex Analysis** | **6B14B MAT Operations Research** | **6B12 MAT Numerical Methods, Fourier Series and Partial Differential Equations** |
| 5 | **6B13 MAT Linear Algebra** | **6B14B MAT Operations Research** | **6B11 MAT Complex Analysis** | **6B12 MAT Numerical Methods, Fourier Series and Partial Differential Equations** | **6B10 MAT Real Analysis II** |
| 6 | **6B14B MAT Operations Research** | **6B13 MAT Linear Algebra** | **6B10 MAT Real Analysis II** | **6B11 MAT Complex Analysis** | **6B12 MAT Numerical Methods, Fourier Series and Partial Differential Equations** |

| | |
|---|---|
| **Subject Code:** | **6B10 MAT** |
| **Subject Name:** | **Real Analysis II** |
| **No. of Credits:** | **4** |
| **No. of Contact Hours:** | **90** |
| **Hours per Week:** | **6** |
| **Name of the Teacher:** | **Anil M V** |

# 6B10 MAT Real Analysis II

**Unit I – Uniform continuity and Monotone functions (20 hours)**

Uniform Continuity, Monotone and Inverse Functions (Sections 5.4, 5.6 of Text 1).

**Unit II – Riemann Integral (25 hours)**

Riemann Integral, Riemann Integrable functions (proof of Additivity theorem is excluded), The Fundamental Theorem of Calculus (Lebesgue's Integrability Criterion and proof of Composition Theorem are excluded) (Sections 7.1,7.2, 7.3 of Text 1).

**Unit III - Improper Integrals and Beta and Gamma Functions (25 hours)**

Improper Integrals (Section 8.7 of Text 2).
Beta and Gamma Functions – Definitions, Properties of Beta and Gamma Functions, Transformations of Gamma Function, Some Important Deductions, Duplication formula (Sections 7.1, 7.2, 7.3, 7.4, 7.5 of Text 3).

**Unit IV – Sequence and Series of Functions and Metric spaces (20 hours)**

Pointwise and Uniform Convergence, Interchange of Limits, Series of Functions (Sections 8.1, 8.2, 9.4 of Text 1).
Metric Spaces – Definition, examples, neighbourhood of a point (Relevant topics from section 11.4 of the Text 1).

**Texts**

1. R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis (4th edition), Wiley
2. G.B. Thomas Jr., M.D. Weir and J.R. Hass, Thomas' Calculus (12th edition), Pearson Education
3. S. Narayan and P.K. Mittal, Integral Calculus (11th edition), S. Chand Publishers.

# TEACHING SCHEDULE

| No of Weeks | Dates | Session | Topic |
|---|---|---|---|
| 1 | 03-01-2022 To 08-01-2022 | 1 | Uniform continuity |
| | | 2 | Basic results |
| | | 3 | Definition |
| | | 4 | Examples |
| | | 5 | Non uniform continuity criteria |
| | | 08 January | Second Saturday |
| 2 | 10-01-2022 To 15-01-2022 | 6 | Uniform continuity theorem |
| | | 7 | Lipschitz functions |
| | | 8 | Examples, Theorem |
| | | 9 | The continuous extension theorem |
| | | 10 | Theorem |
| | | 11 | Step function |
| 3 | 17-01-2022 To 22-01-2022 | 12 | Theorem, Corollary |
| | | 13 | Weierstrass approximation theorem |
| | | 14 | Monotone functions |
| | | 15 | Theorem, corollary |
| | | 16 | Theorem |
| | | 17 | Continuous inverse theorem |
| 4 | 24-01-2022 To 29-01-2022 | 18 | The nth root function |
| | | 19 | Theorem |
| | | 26 January | Republic Day |
| | | 20 | Class test |
| | | 21 | Partitions and Riemann sum |
| | | 22 | Definition of Riemann integrals |
| 5 | 31-01-2022 To 05-02-2022 | 31 January | Don Bosco |
| | | 23 | Theorem |
| | | 24 | Examples |
| | | 25 | Properties of the integrals |
| | | 26 | Boundedness theorem |
| | | 27 | Riemann integrable functions |
| 6 | 07-02-2022 To 12-02-2022 | 28 | Cauchy criterion |
| | | 29 | Squeeze theorem |
| | | 30 | Lemma |
| | | 31 | Additivity Theorem |
| | | 32 | The Fundamental theorem of calculus first form |

| No of Weeks | Dates | Session | Topic |
|---|---|---|---|
| | | 12 February | Second Saturday |
| 7 | 14-02-2022 To 19-02-2022 | 33 | Theorem |
| | | 34 | Definitions |
| | | 35 | The Fundamental theorem of calculus first form |
| | | 36 | Substitution theorem |
| | | 37 | Composition theorem |
| | | 38 | The Product theorem and Integration by parts |
| 8 | 21-02-2022 To 26-02-2022 | 39 | I Internal Examination |
| | | 40 | I Internal Examination |
| | | 41 | I Internal Examination |
| | | 42 | I Internal Examination |
| | | 43 | I Internal Examination |
| | | 44 | I Internal Examination |
| 9 | 28-02-2022 To 05-03-2022 | 45 | Improper integrals |
| | | 01 March | Maha Sivarathri |
| | | 46 | Properties |
| | | 47 | Examples |
| | | 48 | Beta and gamma functions |
| | | 49 | Properties of Beta and gamma functions |
| 10 | 07-03-2022 To 12-03-2022 | 50 | Evaluation of Gamma function |
| | | 51 | Transformation of Gamma function |
| | | 52 | Transformation of beta function |
| | | 53 | Relation between Beta and Gamma function |
| | | 54 | Important deductions |
| | | 12 March | **Second Saturday** |
| 11 | 14-03-2022 To 19-03-2022 | 55 | Assignment |
| | | 56 | Duplication formula |
| | | 57 | Discussion of exercise questions |
| | | 58 | Discussion of exercise questions |
| | | 59 | Discussion of exercise questions |
| | | 60 | Pointwise convergence |
| 12 | 21-03-2022 To 26-03-2022 | 61 | Examples |
| | | 62 | Uniform convergence |
| | | 63 | Examples |
| | | 64 | Lemma |
| | | 65 | The uniform norm |
| | | 66 | Cauchy criterion for uniform convergence |
| 13 | 28-03-2022 | 67 | Interchange of limit and continuity |

| No of Weeks | Dates | Session | Topic |
|---|---|---|---|
| | To 02-04-2022 | 68 | Interchange of limit and derivative |
| | | 69 | Interchange of limit and integral |
| | | 70 | Bounded convergence theorem |
| | | 71 | Dini's theorem |
| | | 72 | Assignment |
| **14** | 04-04-2022 To 09-04-2022 | 73 | Series of functions |
| | | 74 | Tests for uniform convergence |
| | | 75 | Cauchy Hadamard theorem |
| | | 76 | Differentiation theorem |
| | | 77 | Uniqueness theorem |
| | | 09 April | Second Saturday |
| **15** | 11-04-2022 To 16-04-2022 | 78 | Metric spaces-definition and examples |
| | | 79 | Neighborhood of a point |
| | | 13 April | Easter Holidays |
| | | 14 April | Easter Holidays |
| | | 15 April | Easter Holidays |
| | | 16 April | Easter Holidays |
| **16** | 18-04-2022 To 23-04-2022 | 18 April | Easter Holidays |
| | | 80 | Completeness in metric spaces |
| | | 81 | Exercise question discussion |
| | | 82 | Class test |
| | | 83 | Revision |
| | | 84 | Revision |
| **17** | 25-04-2022 To 30-04-2022 | 85 | II Internal Examination |
| | | 86 | II Internal Examination |
| | | 87 | II Internal Examination |
| | | 88 | II Internal Examination |
| | | 89 | II Internal Examination |
| | | 90 | II Internal Examination |

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|---|---|
| **Subject Code:** | **6B11MAT** |
| **Subject Name:** | **Complex Analysis** |
| **No. of Credits:** | **4** |
| **No. of Contact Hours:** | **90** |
| **Hours per Week:** | **6** |
| **Name of the Teacher:** | **Ajeena Joseph** |

**SYLLABUS**

**Text: E.Kreyzig , Adavnced Engineering Mathematics, 10th edition, John Wiley.**

**UNIT I: Complex functions and Analyticity**

Complex functions, Limit and Continuity, Analytic functions, Cauchy- Reimann equations, Laplace equations, Exponential function, Trigonometric and Hypergeometric functions, Euler's formula, Logarithmic functions, General power, Principal value

(Sections 13.3, 13.4, 13.5, 13.6, 13.7 of Text)

**UNIT II: Complex Integration**

Line integrals in the complex plane, Cauchy's integral theorem, Cauchy's integral formula, Derivatives of analytic functions.

( Sections 14.1, 14.2, 14.3, 14.4 of Text)

**UNIT III: Power Series and Taylor Series**

Sequence and series, convergence, Power series, Functions given by power series, Taylor's and Maclaurin series.

( Sections 15.1, 15.2, 15.3, 15.4 of Text)

**UNIT IV: Laurent's Series and Residue Integration**

Laurent's series, Singularities and zeros, Infinity, Residue Integration method.

( Sections 16.1, 16.2, 16.3 of Text )

# TEACHING SCHEDULE

| No of Weeks | Dates | Session | Topic |
|---|---|---|---|
| 1 | 03-01-2022 To 08-01-2022 | 1 | Complex functions |
| | | 2 | Examples |
| | | 3 | Problems |
| | | 4 | Limit and continuity |
| | | 5 | Problems |
| | | 08 January | Second Saturday |
| 2 | 10-01-2022 To 15-01-2022 | 6 | Differentiability |
| | | 7 | Problems |
| | | 8 | Class test |
| | | 9 | Analytic functions |
| | | 10 | Examples |
| | | 11 | Problems |
| 3 | 17-01-2022 To 22-01-2022 | 12 | Catchy- Reimann equations |
| | | 13 | Problems |
| | | 14 | Problems |
| | | 15 | Exponential function |
| | | 16 | Problems |
| | | 17 | Trigonometry functions |
| 4 | 24-01-2022 To 29-01-2022 | 18 | Class test |
| | | 19 | Logarithmic functions |
| | | 26 January | Republic Day |
| | | 20 | Problems |
| | | 21 | Problems |
| | | 22 | General power |
| 5 | 31-01-2022 To 05-02-2022 | 31 January | Don Bosco |
| | | 23 | Principal value |
| | | 24 | Problems |
| | | 25 | Assignment |
| | | 26 | Line integrals |
| | | 27 | Problems |
| 6 | 07-02-2022 To 12-02-2022 | 28 | Problems |
| | | 29 | Cauchy's theorem |
| | | 30 | Class test |
| | | 31 | Problems |
| | | 32 | Problems |

| No of Weeks | Dates | Session | Topic |
|---|---|---|---|
| | | 12 February | Second Saturday |
| 7 | 14-02-2022 To 19-02-2022 | 33 | Cauchy's Integral formula |
| | | 34 | Problems |
| | | 35 | Problems |
| | | 36 | Derivative of analytic functions |
| | | 37 | Problems |
| | | 38 | Problems |
| 8 | 21-02-2022 To 26-02-2022 | 39 | I Internal Examination |
| | | 40 | I Internal Examination |
| | | 41 | I Internal Examination |
| | | 42 | I Internal Examination |
| | | 43 | I Internal Examination |
| | | 44 | I Internal Examination |
| 9 | 28-02-2022 To 05-03-2022 | 45 | Examples |
| | | 01 March | Maha Sivarathri |
| | | 46 | Sequence and series of complex functions |
| | | 47 | Sequence and series of complex functions |
| | | 48 | Sequence and series of complex functions |
| | | 49 | Power series |
| 10 | 07-03-2022 To 12-03-2022 | 50 | Examples |
| | | 51 | Problems |
| | | 52 | Problems |
| | | 53 | Assignment |
| | | 54 | Problems |
| | | 12 March | **Second Saturday** |
| 11 | 14-03-2022 To 19-03-2022 | 55 | Taylor's series |
| | | 56 | Problems |
| | | 57 | Problems |
| | | 58 | Problems |
| | | 59 | Maclaurin series |
| | | 60 | Maclaurin series |
| 12 | 21-03-2022 To 26-03-2022 | 61 | Problems |
| | | 62 | Problems |
| | | 63 | Problems |
| | | 64 | Seminar |
| | | 65 | Seminar |
| | | 66 | Laurent's series |
| 13 | 28-03-2022 | 67 | Problems |

| No of Weeks | Dates | Session | Topic |
|---|---|---|---|
| | To 02-04-2022 | 68 | Singularity |
| | | 69 | Class test |
| | | 70 | Problems |
| | | 71 | Problems |
| | | 72 | Zeros at infinity |
| 14 | 04-04-2022 To 09-04-2022 | 73 | Problems |
| | | 74 | Residues |
| | | 75 | Class test |
| | | 76 | Residues |
| | | 77 | Problems |
| | | 09 April | Second Saturday |
| 15 | 11-04-2022 To 16-04-2022 | 78 | Problems |
| | | 79 | Integration method |
| | | 13 April | Easter Holidays |
| | | 14 April | Easter Holidays |
| | | 15 April | Easter Holidays |
| | | 16 April | Easter Holidays |
| 16 | 18-04-2022 To 23-04-2022 | 18 April | Easter Holidays |
| | | 80 | Integration method |
| | | 81 | Problems |
| | | 82 | Problems |
| | | 83 | Revision |
| | | 84 | Revision |
| 17 | 25-04-2022 To 30-04-2022 | 85 | II Internal Examination |
| | | 86 | II Internal Examination |
| | | 87 | II Internal Examination |
| | | 88 | II Internal Examination |
| | | 89 | II Internal Examination |
| | | 90 | II Internal Examination |

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|---|---|
| **Subject Code:** | **6B12 MAT** |
| **Subject Name:** | **Numerical Methods, Fourier Series And Partial Differential Equations** |
| **No. of Credits:** | **4** |
| **No. of Contact Hours:** | **90** |
| **Hours per Week:** | **6** |
| **Name of the Teacher:** | **Athulya P** |

**6B12 MAT:**
**Numerical Methods, Fourier series and**
**Partial Differential Equations**

**Unit I- Interpolation (25 Hours)**
Interpolation with unevenly spaced points, Langrange interpolation, Newton's divided differences interpolation, Finite difference operators and finite differences, Newton's interpolation formulae, Central difference interpolation. (Sections 4.2, 4.2.1, 4.2.3, 4.3.1, 4.3.2, 4.3.3 of Text 1).

**Unit II - Numerical Solution of Differential Equations (25 Hours)**
Introduction, Picard's method, Solution by Taylor series method, Euler method, Runge-Kutta methods (Sections 7.1, 7.2, 7.3, 7.4, 7.5 of Text 1).

**Unit III - Fourier Series (20 Hours)**
Fourier Series, Arbitrary period, Even and Odd Functions, Half-Range Expansions, Fourier Integrals (Sections 11.1, 11.2, 11.7 of Text 2).

**Unit IV – Partial Differential Equations (20 Hours)**
Basic Concepts, Solution by Separating Variables. Use of Fourier Series, D'Alembert's Solution of the Wave Equation. Characteristics, Heat Equation: Solution by Fourier Series (Steady two-dimensional Heat problems, Laplace's equation, unifying power of methods, Electro statistics and Elasticity are excluded), Laplacian in Polar Coordinates (circular membrane, Bessel's equation are excluded). (Sections 12.1, 12.3, 12.4, 12.6, 12.10 of Text 2).

**Texts**
1. S. R. K. Iyengar and R. K. Jain, Mathematical methods, Narosa Publishing House
2. E. Kreyzig, Advanced Engineering Mathematics (10th edition), John Wiley.

# TEACHING SCHEDULE

| No of Weeks | Dates | Session | Topic |
|---|---|---|---|
| 1 | 03-01-2022 To 08-01-2022 | 1 | Interpolation : Introduction |
| | | 2 | Lagrange interpolation |
| | | 3 | Problems |
| | | 4 | Problems |
| | | 5 | Problems |
| | | 08 January | Second Saturday |
| 2 | 10-01-2022 To 15-01-2022 | 6 | Newtons divided differences interpolation |
| | | 7 | Newtons divided differences interpolation |
| | | 8 | Problems |
| | | 9 | Problems |
| | | 10 | Finite difference operators |
| | | 11 | Finite differences |
| 3 | 17-01-2022 To 22-01-2022 | 12 | Finite differences |
| | | 13 | Problems |
| | | 14 | Problems |
| | | 15 | Problems |
| | | 16 | Newtons interpolation formula |
| | | 17 | Newtons interpolation formula |
| 4 | 24-01-2022 To 29-01-2022 | 18 | Problems |
| | | 19 | Problems |
| | | 26 January | Republic Day |
| | | 20 | Central difference interpolation |
| | | 21 | Problems |
| | | 22 | Problems |
| 5 | 31-01-2022 To 05-02-2022 | 31 January | Don Bosco |
| | | 23 | Class Test |
| | | 24 | Numerical Solution of differential equations: Introduction |
| | | 25 | Picards method |
| | | 26 | Picards method |
| | | 27 | Problems |
| 6 | 07-02-2022 To 12-02-2022 | 28 | Solution by Taylor series method |
| | | 29 | Problems |
| | | 30 | Problems |
| | | 31 | Euler method |
| | | 32 | Euler method |

| No of Weeks | Dates | Session | Topic |
|---|---|---|---|
| | | 12 February | Second Saturday |
| 7 | 14-02-2022 To 19-02-2022 | 33 | Problems |
| | | 34 | Problems |
| | | 35 | Runge- Kutta methods |
| | | 36 | Problems |
| | | 37 | Problems |
| | | 38 | Class Test |
| 8 | 21-02-2022 To 26-02-2022 | 39 | I Internal Examination |
| | | 40 | I Internal Examination |
| | | 41 | I Internal Examination |
| | | 42 | I Internal Examination |
| | | 43 | I Internal Examination |
| | | 44 | I Internal Examination |
| 9 | 28-02-2022 To 05-03-2022 | 45 | Fourier Series : Introduction |
| | | 01 March | Maha Sivarathri |
| | | 46 | Fourier Series |
| | | 47 | Arbitrary period |
| | | 48 | Even and Odd functions |
| | | 49 | Even and Odd functions |
| 10 | 07-03-2022 To 12-03-2022 | 50 | Problems |
| | | 51 | Problems |
| | | 52 | Problems |
| | | 53 | Problems |
| | | 54 | Problems |
| | | 12 March | **Second Saturday** |
| 11 | 14-03-2022 To 19-03-2022 | 55 | Half Range Expansions |
| | | 56 | Half Range Expansions |
| | | 57 | Half Range Expansions |
| | | 58 | Problems |
| | | 59 | Problems |
| | | 60 | Problems |
| 12 | 21-03-2022 To 26-03-2022 | 61 | Problems |
| | | 62 | Fourier Integrals |
| | | 63 | Problems |
| | | 64 | Problems |
| | | 65 | Problems |
| | | 66 | Class Tests |
| 13 | 28-03-2022 | 67 | Partial differential equations |

| No of Weeks | Dates | Session | Topic |
|---|---|---|---|
| | To 02-04-2022 | 68 | Basic Concepts |
| | | 69 | Solution by separating variables |
| | | 70 | Use of Fourier series |
| | | 71 | D'Alembert's Solution of the wave equation. |
| | | 72 | D'Alembert's Solution of the wave equation. |
| **14** | 04-04-2022 To 09-04-2022 | 73 | Problems |
| | | 74 | Problems |
| | | 75 | Problems |
| | | 76 | Characteristics |
| | | 77 | Heat equation : Solution by Fourier Series |
| | | 09 April | Second Saturday |
| **15** | 11-04-2022 To 16-04-2022 | 78 | Heat equation : Solution by Fourier Series |
| | | 79 | Class Test |
| | | 13 April | Easter Holidays |
| | | 14 April | Easter Holidays |
| | | 15 April | Easter Holidays |
| | | 16 April | Easter Holidays |
| **16** | 18-04-2022 To 23-04-2022 | 18 April | Easter Holidays |
| | | 80 | Laplacian in polar coordinates |
| | | 81 | Laplacian in polar coordinates |
| | | 82 | Problems |
| | | 83 | Revision |
| | | 84 | Revision |
| **17** | 25-04-2022 To 30-04-2022 | 85 | II Internal Examination |
| | | 86 | II Internal Examination |
| | | 87 | II Internal Examination |
| | | 88 | II Internal Examination |
| | | 89 | II Internal Examination |
| | | 90 | II Internal Examination |

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|---|---|
| **Subject Code:** | **6B13 MAT** |
| **Subject Name:** | **Linear Algebra** |
| **No. of Credits:** | **4** |
| **No. of Contact Hours:** | **90** |
| **Hours per Week:** | **6** |
| **Name of the Teacher:** | **PRIJA V** |

**SYLLABUS :**

## 6B13 MAT: Linear Algebra

**Unit I – Vector Spaces (20 Hours)**
Introduction, Vector spaces, Subspaces, Linear Combinations and Systems of Linear Equations (Sections 1.1, 1.2, 1.3 of Text 1).

**Unit II – Bases and Dimension (20 Hours)**
Linear Dependence and Linear Independence, Bases and Dimension, Maximal Linearly Independent Subsets (Sections 1.5, 1.6, 1.7 of Text 1).

**Unit III - Linear Transformations, Matrices (25 Hours)**
Linear Transformations, Null Spaces, and Ranges (Proof of Theorem 2.3 excluded), The Matrix Representation of a Linear Transformation (Sections 2.1, 2.2 of Text 1) (Operations of Linear Transformations and related theorems are excluded).
Introduction, Rank of a matrix, Elementary transformations of a matrix, Invariance of rank through elementary transformations, Elementary transformations of a matrix do not alter its rank, Multiplication of the elements of a row by a non zero number does not alter the rank, Addition to the elements of a row the products by a number of the corresponding elements of a row does not alter the rank, Reduction to normal form (Proof of theorem excluded), Elementary Matrices, Elementary Transformations and elementary matrices, Employment of only row (column) transformations, The rank of a product, A Convenient method for computing the inverse of a non singular matrix by elementary row transformations (Sections 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13 of Text 2).

**Unit IV - System of linear equations, Eigen values and Eigen vectors (25 Hours)**
Introduction, System of linear homogeneous equations, Null space and nullity of matrix, Sylvester's law of nullity, Range of a matrix, Systems of linear non homogeneous equations (Sections 6.1, 6.2, 6.3, 6.4, 6.5, 6.6 of Text 2) Eigen values, eigen vectors, Properties of eigen values, CayleyHamilton theorem(without proof). (Sections 2.13, 2.14, 2.15 of Text 3)

**Texts**
1. S.H. Friedberg, A. J. Insel and L.E. Spence, Linear Algebra (4th edition), PH Inc
2. S. Narayan and Mittal, A Text Book of Matrices (Revised edition), S. Chand

# TEACHING SCHEDULE

| No of Weeks | Dates | Session | Topic |
|---|---|---|---|
| 1 | 03-01-2022 To 08-01-2022 | 1 | Unit I – Vector Spaces –Introduction. |
| | | 2 | Vector spaces ,Definitions. |
| | | 3 | Examples, Exercise questions. |
| | | 4 | Theorem. |
| | | 5 | Subspaces ,Definitions. |
| | | 08 January | Second Saturday |
| 2 | 10-01-2022 To 15-01-2022 | 6 | Examples, Exercise questions. |
| | | 7 | Theorem. |
| | | 8 | Theorem. |
| | | 9 | Class test. |
| | | 10 | Exercise questions. |
| | | 11 | Linear Combinations and Systems of Linear Equations. |
| 3 | 17-01-2022 To 22-01-2022 | 12 | Definitions. |
| | | 13 | Examples, Exercise questions. |
| | | 14 | Theorem. |
| | | 15 | Theorem. |
| | | 16 | Unit Test. |
| | | 17 | Unit II – Bases and Dimension - Introduction. |
| 4 | 24-01-2022 To 29-01-2022 | 18 | Examples, Exercise questions. |
| | | 19 | Theorem. |
| | | 26 January | Republic Day |
| | | 20 | Linear Dependence and Linear Independence- Definitions. |
| | | 21 | Examples, Exercise questions. |
| | | 22 | Theorem. |
| 5 | 31-01-2022 To 05-02-2022 | 31 January | Don Bosco |
| | | 23 | Bases and Dimension- Definitions. |
| | | 24 | Class test. |
| | | 25 | Examples, Exercise questions. |
| | | 26 | Theorem. |
| | | 27 | Maximal Linearly Independent Subsets |
| 6 | 07-02-2022 | 28 | Definitions. |
| | | 29 | Examples, Exercise questions. |

| No of Weeks | Dates | Session | Topic |
|---|---|---|---|
| | To 12-02-2022 | 30 | Theorem. |
| | | 31 | Unit Test. |
| | | 32 | Assignment. |
| | | 12 February | Second Saturday |
| 7 | 14-02-2022 To 19-02-2022 | 33 | Unit III - Linear Transformations- Introduction. |
| | | 34 | Matrices |
| | | 35 | Examples, Exercise questions. |
| | | 36 | Theorem. |
| | | 37 | Linear Transformations- Definitions. |
| | | 38 | Examples, Exercise questions. |
| 8 | 21-02-2022 To 26-02-2022 | 39 | I Internal Examination |
| | | 40 | I Internal Examination |
| | | 41 | I Internal Examination |
| | | 42 | I Internal Examination |
| | | 43 | I Internal Examination |
| | | 44 | I Internal Examination |
| 9 | 28-02-2022 To 05-03-2022 | 45 | Assignment. |
| | | 01 March | Maha Sivarathri |
| | | 46 | Null Spaces and Ranges- Definitions. |
| | | 47 | Examples, Exercise questions. |
| | | 48 | Class test. |
| | | 49 | The Matrix Representation of a Linear Transformation- Definitions. |
| 10 | 07-03-2022 To 12-03-2022 | 50 | Theorem. |
| | | 51 | Examples, Exercise questions |
| | | 52 | Rank of a matrix |
| | | 53 | Examples, Exercise questions |
| | | 54 | Elementary transformations of a matrix |
| | | 12 March | **Second Saturday** |
| 11 | 14-03-2022 To 19-03-2022 | 55 | Elementary Matrices. |
| | | 56 | Elementary Transformations and elementary matrices, Employment of only row (column) transformations- Examples, Exercise questions |
| | | 57 | Invariance of rank through elementary transformations- Examples, Exercise questions |
| | | 58 | The rank of a product |
| | | 59 | Class test. |

| No of Weeks | Dates | Session | Topic |
|---|---|---|---|
| | | 60 | Elementary transformations of a matrix do not alter its rank |
| 12 | 21-03-2022 To 26-03-2022 | 61 | A Convenient method for computing the inverse of a non singular matrix by elementary row transformations- Examples, Exercise questions |
| | | 62 | Examples, Exercise questions |
| | | 63 | Examples, Exercise questions |
| | | 64 | Multiplication of the elements of a row by a non zero number does not alter the rank- Examples, Exercise questions |
| | | 65 | Theorem. |
| | | 66 | Examples, Exercise questions |
| 13 | 28-03-2022 To 02-04-2022 | 67 | Examples, Exercise questions |
| | | 68 | Addition to the elements of a row the products by a number of the corresponding elements of a row does not alter the rank- Examples, Exercise questions. |
| | | 69 | Reduction to normal form |
| | | 70 | Unit test. |
| | | 71 | Unit IV - System of linear equations, Eigen values and Eigen vectors –Introduction. |
| | | 72 | System of linear homogeneous equations |
| 14 | 04-04-2022 To 09-04-2022 | 73 | Examples, Exercise questions |
| | | 74 | Theorem. |
| | | 75 | Null space and nullity of matrix |
| | | 76 | Theorem. |
| | | 77 | Sylvester's law of nullity, |
| | | 09 April | Second Saturday |
| 15 | 11-04-2022 To 16-04-2022 | 78 | Range of a matrix- Examples, Exercise questions |
| | | 79 | Class test. |
| | | 13 April | Easter Holidays |
| | | 14 April | Easter Holidays |
| | | 15 April | Easter Holidays |
| | | 16 April | Easter Holidays |
| 16 | 18-04-2022 To 23-04-2022 | 18 April | Easter Holidays |
| | | 80 | Theorem. |
| | | 81 | Systems of linear non homogeneous equations |
| | | 82 | Eigen vectors, Eigen values, Properties of eigen values, CayleyHamilton theorem. |
| | | 83 | Revision. |

| No of Weeks | Dates | Session | Topic |
|---|---|---|---|
| | | 84 | Revision. |
| 17 | 25-04-2022 To 30-04-2022 | 85 | II Internal Examination |
| | | 86 | II Internal Examination |
| | | 87 | II Internal Examination |
| | | 88 | II Internal Examination |
| | | 89 | II Internal Examination |
| | | 90 | II Internal Examination |

| | |
|---|---|
| **Subject Code:** | **6B 14A MAT** |
| **Subject Name:** | **Operations Research** |
| **No. of Credits:** | **4** |
| **No. of Contact Hours:** | **90** |
| **Hours per Week:** | **6** |
| **Name of the Teacher:** | **RIYA BABY,PRIJA V, AJEENA JOSEPH** |

# 6B14B MAT: Operations Research

**Unit I - Linear Programming Problem (30 hours)**

Convex sets and their properties, Convex Functions, Local and Global Extrema, Quadratic Forms.
Linear Programming Problem – Mathematical formulation, Graphical solution, General Linear Programming Problem , Slack and Surplus Variables, Canonical and standard form of LPP, Insights into the simplex method. Basic Solution, Degenerate Solution, Basic Feasible Solution, Associated cost vector, Improved basic Feasible solution, Optimum Basic Feasible Solution, Fundamental Properties of solution (Proof of theorems omitted), Simplex method – The computational Procedure, The Simplex Algorithm.
General Primal-Dual Pair, Formulating a dual problem (Sections 0:13, 0:15, 0:16, 0:17, 2:1, 2:2, 2:3, 2:4, 3:1, 3:2, 3:4, 3:5, 3:6, 4:1, 4:2, 4:3, 5:1, 5:2, 5:3of the Text).

**Unit II - Transportation Problem (25 hours)**

LP formulation of the Transportation Problem, Existence of solution in T.P, Duality in Transportation problem, The Transportation Table, Loops in Trasportation Tables, Triangular basis in a T.P (proof of theorem Omitted), Solution of a Trasportation problem, North-west corner Method, Least –Cost Method, VAM, Test For Optimality, Degeneracy in TP, MODI Method. (Sections 10:1,10:2,10:3,10:4,10:5,10:6,10:7,10:8,10:9,10:10,10:12,10:13 of the Text)

**Unit III - Assignment Problem and Sequencing Problem (20 hours)**

**Assignment Problem**: Mathematical Formulation of Assignment Problem, Hugarian Assignment Method.
**Sequencing Problem**: Problem of sequencing, Basic terms used in sequencing, Processing ‘n’ jobs through ‘2’ machines, Processing ‘n’ jobs through ‘k’ machines, Maintenance Crew Scheduling.
(Sections 11:1, 11:2, 11:3, 12:1, 12:2, 12:3, 12:4, 12:5, 12:7 of the Text)

**Unit IV - Games and Strategies (15 hours)**

Two-person Zero-sum Games, Basic terms in Game theory, The Maximin-Minimax Principle, Solution of game with saddle point, Solution of 2x2 game without saddle point, Graphic solution of 2xn and mx2 games, Dominance Property, Modified Dominance Property, Arithmetic Method for nxn Games. (Proofs of all theorems in this unit are omitted).
(Sections 17:1, 17:2, 17:3, 17:4, 17:5, 17:6, 17:7, 17:8 of the Text)
56

**Text**

K. Swarup, P.K.Gupta and M. Mohan, Operations Research (18th edition), Sulthan Chand and Sons.

# TEACHING SCHEDULE

| No of Weeks | Dates | Session | Topic |
|---|---|---|---|
| 1 | 03-01-2022 To 08-01-2022 | 1 | Convex sets and their properties |
| | | 2 | Convex function, Local and global extreme |
| | | 3 | Quadratic forms |
| | | 4 | Theorems |
| | | 5 | Quadratic forms |
| | | 08 January | Second Saturday |
| 2 | 10-01-2022 To 15-01-2022 | 6 | General linear programming problem canonical and standard forms of LPP. |
| | | 7 | Theory |
| | | 8 | Problems |
| | | 9 | Problem solving |
| | | 10 | Solutions and fundamental properties of solutions of LPP |
| | | 11 | Theorems |
| 3 | 17-01-2022 To 22-01-2022 | 12 | Problem solving |
| | | 13 | Problem solving |
| | | 14 | Problem solving |
| | | 15 | Graphical solution method |
| | | 16 | Graphical solution method |
| | | 17 | Problem solving |
| 4 | 24-01-2022 To 29-01-2022 | 18 | Problem solving |
| | | 19 | Problem solving |
| | | 26 January | Republic Day |
| | | 20 | Simplex method |
| | | 21 | Simplex method |
| | | 22 | Simplex method |
| 5 | 31-01-2022 To 05-02-2022 | 31 January | Don Bosco |
| | | 23 | Duality in linear programming General primal - dual pair |
| | | 24 | Duality in linear programming General primal - dual pair |
| | | 25 | Duality in linear programming General primal - dual pair |
| | | 26 | Problem solving |

| No of Weeks | Dates | Session | Topic |
|---|---|---|---|
| | | 27 | Problem solving |
| 6 | 07-02-2022 To 12-02-2022 | 28 | TEST PAPER |
| | | 29 | General transportation problem, the transportation tables. |
| | | 30 | Theorems |
| | | 31 | Loops in transportation table solution of a transportation problem |
| | | 32 | Problem solving |
| | | 12 February | Second Saturday |
| 7 | 14-02-2022 To 19-02-2022 | 33 | Finding an initial basic Feasible solution |
| | | 34 | Problem solving |
| | | 35 | Problem solving |
| | | 36 | Test for optimality, Degeneracy in transportation problem |
| | | 37 | Transportation algorithm |
| | | 38 | TEST PAPER |
| 8 | 21-02-2022 To 26-02-2022 | 39 | I Internal Examination |
| | | 40 | I Internal Examination |
| | | 41 | I Internal Examination |
| | | 42 | I Internal Examination |
| | | 43 | I Internal Examination |
| | | 44 | I Internal Examination |
| 9 | 28-02-2022 To 05-03-2022 | 45 | Solution methods of Assignment problem |
| | | 01 March | Maha Sivarathri |
| | | 46 | Solution methods of Assignment problem |
| | | 47 | Problem of sequencing, Basic terms used in sequencing. |
| | | 48 | Problem of sequencing, Basic terms used in sequencing. |
| | | 49 | processing n Jobs through two machines |
| 10 | 07-03-2022 To 12-03-2022 | 50 | Problem solving |
| | | 51 | Problem solving |
| | | 52 | Problem solving |
| | | 53 | Processing n jobs through k machines |
| | | 54 | Problem solving |
| | | 12 March | **Second Saturday** |
| 11 | 14-03-2022 To | 55 | Processing 2 jobs through k machines, |
| | | 56 | Processing 2 jobs through k machines, |
| | | 57 | Problem solving |

| No of Weeks | Dates | Session | Topic |
|---|---|---|---|
| | 19-03-2022 | 58 | Problem solving |
| | | 59 | Problem solving |
| | | 60 | Maintenance crew scheduling. |
| 12 | 21-03-2022 To 26-03-2022 | 61 | Maintenance crew scheduling. |
| | | 62 | seminar |
| | | 63 | seminar |
| | | 64 | seminar |
| | | 65 | seminar |
| | | 66 | seminar |
| 13 | 28-03-2022 To 02-04-2022 | 67 | Two- person zero-sum games, Some basic terms, |
| | | 68 | Two- person zero-sum games, Some basic terms, |
| | | 69 | Theorems |
| | | 70 | Theorems |
| | | 71 | Problem solving |
| | | 72 | Problem solving |
| 14 | 04-04-2022 To 09-04-2022 | 73 | The maximin - minimax principle |
| | | 74 | Games without saddle points mixed strategies |
| | | 75 | Games without saddle points mixed strategies |
| | | 76 | Problem solving |
| | | 77 | Problem solving |
| | | 09 April | Second Saturday |
| 15 | 11-04-2022 To 16-04-2022 | 78 | Test paper |
| | | 79 | Graphic solution of 2xn and nx2 games, Dominance property |
| | | 13 April | Easter Holidays |
| | | 14 April | Easter Holidays |
| | | 15 April | Easter Holidays |
| | | 16 April | Easter Holidays |
| 16 | 18-04-2022 To 23-04-2022 | 18 April | Easter Holidays |
| | | 80 | Arithmetic method for nxn games. |
| | | 81 | Arithmetic method for nxn games. |
| | | 82 | Test paper |

| No of Weeks | Dates | Session | Topic |
|---|---|---|---|
| | | 83 | Problem solving |
| | | 84 | Question paper discussion |
| 17 | 25-04-2022 To 30-04-2022 | 85 | II Internal Examination |
| | | 86 | II Internal Examination |
| | | 87 | II Internal Examination |
| | | 88 | II Internal Examination |
| | | 89 | II Internal Examination |
| | | 90 | II Internal Examination |