

**Syllabus for  
Bachelor of Science in Mathematics (Gen/Pass)  
Under Choice Based Credit System**

**Academic Session:  
w.e.f. 2020-2023**



*for*  
**All Constituent/Affiliated Colleges Under  
Binod Bihari Mahto Koyalanchal University,  
Dhanbad**

Members of Board of Studies of CBCS Under – Graduate Syllabus as per guidelines of the Binod Bihari Mahato Koyalanchal University , Dhanbad.

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Head, Department of Mathematics , PKRM College, Dhanbad

5. Special Invitee: **Dr. B.K. Singh (Rtd.)**

Associate Professor

Head, Department of Mathamtics , B.S.City College, Bokaro.

  
(DR. R.K. TIWARY)  
H.O.D.

**H.O.D.**

P.G. Department of Mathematics  
B.B.M.K.U. Dhanbad

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## COURSE STRUCTURE

Semester	Course Code	Name of Paper	Full Marks	End Semester Marks	Mid Semester (Internal) Marks
I	<b>MAT-G-DSC-101A-T</b> (06 Credits, 60 Lectures & 15 Tutorials)		100	80	20
	<b>MAT-G-AECC-101-T</b> Language (English/Hindi/NI+MB) (02 Credits, 30 Lectures)		50	40	10
II	<b>MAT-G-DSC-201B-T</b> (06 Credits, 60 Lectures & 15 Tutorials)		100	80	20
	<b>MAT-G-AECC-202-T</b> Environmental Science (02 Credits, 30 Lectures)		50	40	10
III	<b>MAT-G-DSC-301C-T</b> (06 Credits, 60 Lectures & 15 Tutorials)		100	80	20
	<b>XYZ-G-SEC-301-T</b> (02 Credits, 30 Lectures) (Annexure-1)		50	40	10
IV	<b>MAT-G-DSC-401D-T</b> (06 Credits, 60 Lectures & 15 Tutorials)		100	80	20
	<b>MAT-G-SEC-402-T</b> (02 Credits, 30 Lectures) (Annexure-1)		50	40	10
V	<b>MAT-G-DSE-501A-T</b> (06 Credits, 60 Lectures & 15 Tutorials)		100	80	20
	<b>MAT-G-SEC-503-T</b> (02 Credits, 30 Lectures) (Annexure-1)		50	40	10
VI	<b>MAT-G-DSE-601B-T</b> (06 Credits, 60 Lectures & 15 Tutorials)		100	80	20
	<b>MAT-G-SEC-604-T</b> (02 Credits, 30 Lectures) (Annexure-1)		50	40	10
<b>Total Marks</b>			<b>900</b>	<b>720</b>	<b>180</b>

**Note:**

- For General/Pass Course: In Core Courses as DSC: select 03 papers from each of the 03 disciplines of choice for Semester I to IV and in Elective Courses as DSE: select 02 papers from each of the 03 disciplines of choice including interdisciplinary nature for Semester V to VI.
- **Symbol of Paper:** XYZ-H-C-101-T: The first three symbols in Roman capital letters indicate the subject; the next symbol H or G indicate Honours or General course; the next symbol(s) denotes Core (C), Generic Elective (GE), Discipline Specific Elective (DSE), Discipline Specific Choice (DSC),

AECC, SEC, etc. Out of the next three digits, the first digit indicates the semester e.g. 1,2,3,4,5,6 for semester I, II, III, IV, V, VI respectively, and the next two digits indicate paper number. The last letter T or P indicates Theory or Practical.

**Subject Combinations allowed for B. Sc. General Programme:**

	<b>Subject 1</b>	<b>Subject 2</b>	<b>Subject 3</b>
<b>1</b>	Mathematics	Physics	Chemistry
<b>2</b>	Mathematics	Physics	Geology
<b>3</b>	Mathematics	Chemistry	Geology

**SEMESTER-I**

<b>MAT-G-AECC-101-T</b>	Language (English / Hindi / NH+MB)	(02 Credits, 30 Lectures)
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<b>Full Marks: 10 (MSE: ½ Hrs) + 40 (ESE: 1 ½ Hrs) = 50</b>
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<b>Pass Marks: (MSE: 4) + (ESE: 16) = 20</b>
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A Common Syllabus Prescribed by BBMKU, Dhanbad

**Theory: 30 Lectures**

**Instruction to Question Setter for End Semester Examination (ESE):** There will be two groups of questions. Five Questions to be answered out of Nine Questions. Group A is compulsory and will contain two questions. Question No.1 (A) will be MCQ of 1 mark each (four questions). Question No.1 (B) will be short answer type to be answered in about 50 words of 2 marks (2 Questions). Group B will contain descriptive type eight questions of eight marks each, out of which any four are to answer. Each question carries 08 marks.

**MAT-G-DSC-101A-T: Differential Calculus****(06 Credits, 60 Lectures)**

<b>Marks: 20 (MSE: 1Hr) + 80 (ESE: 3Hrs) = 100</b>
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<b>Pass Marks (MSE: 8 + ESE: 32) = 40</b>
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**Instruction to Question Setter for:****Mid Semester Examination (MSE):**

There will be two group of questions. Group A is compulsory and will contain five questions of very short answer type consisting of 1 mark each. Group B will contain descriptive type five questions of five marks each, out of which any three are to answer.

**End Semester Examination (ESE):**

There will be two group of questions. Group A is compulsory and will contain two questions. Question No.1 will be very short answer type consisting of eight questions of 1 mark each. Question No.2 will be short answer type consisting two question of 4 marks. Group B will contain descriptive type seven questions of sixteen marks each, out of which any four are to answer.

**Note:** There may be subdivisions in each question asked in End Semester Examinations.

**UNIT I**

Limit and Continuity ( $\epsilon$  and  $\delta$  definition), Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz's theorem, Partial differentiation, Euler's theorem on homogeneous functions

(3 Questions)

**UNIT II**

Tangents and normals, Curvature, Asymptotes, Singular points, Tracing of curves. Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar coordinates.

(3 Questions)

**UNIT III**

Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms



of remainder, Taylor's series, Maclaurin's series of  $\sin x$ ,  $\cos x$ ,  $e^x$ ,  $\log(1+x)$ ,  $(1+x)^n$ , Maxima and Minima, Indeterminate forms.

(2 Questions)

**Books Recommended**

1. H. Anton, I. Birens and S. Davis, *Calculus*, John Wiley and Sons, Inc., 2002.
2. G.B. Thomas and R.L. Finney, *Calculus*, Pearson Education, 2007.

**SEMESTER-II**

**AECC – ENVIRONMENT SCIENCE**

**02 Credit - Theory: 30 Lectures**

**Full Marks: 10 (MSE: ½ Hrs) + 40 (ESE: 1½ Hrs) = 50**

**Pass Marks: (MSE: 4) + (ESE: 16) = 20**

A Common Syllabus Prescribed by BBMKU, Dhanbad

**Theory: 30 Lectures**

*Instruction to Question Setter for End Semester Examination (ESE): There will be two groups of questions. Five Questions to be answered out of Nine Questions. Group A is compulsory and will contain two questions. Question No.1 (A) will be MCQ of 1 mark each (four questions). Question No.1 (B) will be short answer type to be answered in about 50 words of 2 marks (2 Questions). Group B will contain descriptive type eight questions of eight marks each, out of which any four are to answer. Each question carries 08 marks.*

**MAT-G-DSC-201B-T: Differential Equations**

**(06 Credits, 60 Lectures)**

**Marks: 20 (MSE: 1Hr) + 80 (ESE: 3Hrs) = 100**

**Pass Marks (MSE: 8 + ESE: 32) = 40**

**Instruction to Question Setter for:**

**Mid Semester Examination (MSE):**

*There will be two group of questions. Group A is compulsory and will contain five questions of very short answer type consisting of 1 mark each. Group B will contain descriptive type five questions of five marks each, out of which any three are to answer.*

**End Semester Examination (ESE):**

*There will be two group of questions. Group A is compulsory and will contain two questions. Question No.1 will be very short answer type consisting of eight questions of 1 mark each. Question No.2 will be short answer type consisting two question of 4 marks. Group B will contain descriptive type seven questions of sixteen marks each, out of which any four are to answer.*

*Note: There may be subdivisions in each question asked in End Semester Examinations.*

**UNIT I**

First order exact differential equations, Integrating factors, rules to find an integrating factor. First order higher degree equations solvable for x, y, p. Methods for solving higher-order differential equations. Basic theory of linear differential equations, Wronskian, and its properties. Solving a differential equation by reducing its order. (2 Questions)

**UNIT II**

Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method of variation of parameters, The Cauchy-Euler equation, Simultaneous differential equations, Total differential equations. (2 Questions)

**UNIT III**

Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Linear partial differential equation of first order, Lagrange's method, Charpit's method. (3 Questions)

Classification of second order partial differential equations into elliptic, parabolic and hyperbolic through illustrations only. (1 Questions)

**Books Recommended**

1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.
2. I. Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition, 1967.

**SEMESTER-III****Skill Enhancement Course (SEC)**

02 Credit - Theory: 30 Lectures

Full Marks: 10 (MSE: ½ Hrs) + 40 (ESE: 1½ Hrs) = 50

Pass Marks: (MSE: 4) + (ESE: 16) = 20

A Common Syllabus Prescribed by BBMKU, Dhanbad

**Theory: 30 Lectures**

**Instruction to Question Setter for End Semester Examination (ESE):** There will be two groups of questions. Five Questions to be answered out of Nine Questions. Group A is compulsory and will contain two questions. Question No.1 (A) will be MCQ of 1 mark each (four questions). Question No.1 (B) will be short answer type to be answered in about 50 words of 2 marks (2 Questions). Group B will contain descriptive type eight questions of eight marks each, out of which any four are to answer. Each question carries 08 marks.

**MAT-G-DSC-301C-T: Real Analysis**

(06 Credits, 60 Lectures)

Marks: 20 (MSE: 1Hr) + 80 (ESE: 3Hrs) = 100

Pass Marks (MSE: 8 + ESE: 32) = 40

**Instruction to Question Setter for:****Mid Semester Examination (MSE):**



There will be two group of questions. Group A is compulsory and will contain five questions of very short answer type consisting of 1 mark each. Group B will contain descriptive type five questions of five marks each, out of which any three are to answer.

#### End Semester Examination (ESE):

There will be two group of questions. Group A is compulsory and will contain two questions. Question No.1 will be very short answer type consisting of eight questions of 1 mark each. Question No.2 will be short answer type consisting two question of 4 marks. Group B will contain descriptive type seven questions of sixteen marks each, out of which any four are to answer.

Note: There may be subdivisions in each question asked in End Semester Examinations.

#### **UNIT I**

Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, suprema and infima, completeness property of  $\mathbb{R}$ , Archimedean property of  $\mathbb{R}$ , intervals. Concept of cluster points and statement of Bolzano-Weierstrass theorem.

(2 Questions)

#### **UNIT II**

Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences. Cauchy's theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence (monotone convergence theorem without proof).

(2 Questions)

#### **UNIT III**

Infinite series, Cauchy convergence criterion for series, positive term series, geometric series, comparison test, convergence of p-series, Root test, Ratio test, alternating series, Leibnitz's test (Tests of Convergence without proof). Definition and examples of absolute and conditional convergence.

(2 Questions)

#### **UNIT IV**

Sequences and series of functions, Pointwise and uniform convergence, M<sub>n</sub>-test, M-test, Statements of the results about uniform convergence and integrability and differentiability of functions, Power series and radius of convergence.

(2 Questions)

#### **Books Recommended**

1. T. M. Apostol, *Calculus* (Vol. I), John Wiley and Sons (Asia) P. Ltd., 2002.
2. R.G. Bartle and D. R. Sherbert, *Introduction to Real Analysis*, John Wiley and Sons (Asia) P. Ltd., 2000.
3. E. Fischer, *Intermediate Real Analysis*, Springer Verlag, 1983.
4. K.A. Ross, *Elementary Analysis- The Theory of Calculus Series-* Undergraduate Texts in Mathematics, Springer Verlag, 2003.

### SEMESTER-IV

#### **Skill Enhancement Course (SEC)**

02 Credit - Theory: 30 Lectures

Full Marks: 10 (MSE: ½ Hrs) + 40 (ESE: 1½ Hrs) = 50

Pass Marks: (MSE: 4) + (ESE: 16) = 20

**Instruction to Question Setter for End Semester Examination (ESE):** There will be two groups of questions. Five Questions to be answered out of Nine Questions. Group A is compulsory and will contain two questions. Question No.1 (A) will be MCQ of 1 mark each (four questions). Question No.1 (B) will be short answer type to be answered in about 30 words of 2 marks (2 Questions). Group B will contain descriptive type eight questions of eight marks each, out of which any four are to answer. Each question carries 08 marks.

**MAT-G-DSC-401D-T: Algebra;**

**(Credits 06; Lectures-60)**

**Marks: 20 (MSE: 1Hr) + 80 (ESE: 3Hrs) = 100      Pass Marks (MSE: 8 + ESE: 32) = 40**

**Instruction to Question Setter for:**

**Mid Semester Examination (MSE):**

There will be two group of questions. Group A is compulsory and will contain five questions of very short answer type consisting of 1 mark each. Group B will contain descriptive type five questions of five marks each, out of which any three are to answer.

**End Semester Examination (ESE):**

There will be two group of questions. Group A is compulsory and will contain two questions. Question No.1 will be very short answer type consisting of eight questions of 1 mark each. Question No.2 will be short answer type consisting two question of 4 marks. Group B will contain descriptive type seven questions of sixteen marks each, out of which any four are to answer.

*Note: There may be subdivisions in each question asked in End Semester Examinations.*

### UNIT I

Definition and examples of groups, examples of abelian and non-abelian groups, the group  $Z_n$  of integers under addition modulo  $n$  and the group  $U(n)$  of units under multiplication modulo  $n$ . Cyclic groups from number systems, complex roots of unity, circle group, the general linear group  $GL_n(n, R)$ , groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle, (iii) a rectangle, and (iv) a square, the permutation group  $Sym(n)$ , Group of quaternions.

(3 Questions)

### UNIT II

Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets, Index of subgroup, Lagrange's theorem, order of an element, Normal subgroups: their definition, examples, and characterizations, Quotient groups.

(2 Questions)

### UNIT III

Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems,  $Z_n$  the ring of integers modulo  $n$ , ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains and fields, examples of fields:  $Z_p$ ,  $Q$ ,  $R$ , and  $C$ . Field of rational functions.

(3 Questions)



**Books Recommended**

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Joseph A Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa, 1999.
4. George E Andrews, *Number Theory*, Hindustan Publishing Corporation, 1984.

**SEMESTER-V****Skill Enhancement Course (SEC)**

02 Credit - Theory: 30 Lectures

Full Marks: 10 (MSE: ½ Hrs) + 40 (ESE: 1½ Hrs) = 50

Pass Marks: (MSE: 4) + (ESE: 16) = 20

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**Theory: 30 Lectures**

**Instruction to Question Setter for End Semester Examination (ESE):** There will be two groups of questions. Five Questions to be answered out of Nine Questions. Group A is compulsory and will contain two questions. Question No.1 (A) will be MCQ of 1 mark each (four questions). Question No.1 (B) will be short answer type to be answered in about 50 words of 2 marks (2 Questions). Group B will contain descriptive type eight questions of eight marks each, out of which any four are to answer. Each question carries 08 marks.

**MAT-G-DSE-501A-T: Matrices**

(06 Credits, 60 Lectures &amp; 15 Tutorials)

Marks: 20 (MSE: 1Hr) + 80 (ESE: 3Hrs) = 100

Pass Marks (MSE: 8 + ESE: 32) = 40

**Instruction to Question Setter for:****Mid Semester Examination (MSE):**

There will be two group of questions. Group A is compulsory and will contain five questions of very short answer type consisting of 1 mark each. Group B will contain descriptive type five questions of five marks each, out of which any three are to answer.

**End Semester Examination (ESE):**

There will be two group of questions. Group A is compulsory and will contain two questions. Question No.1 will be very short answer type consisting of eight questions of 1 mark each. Question No.2 will be short answer type consisting two question of 4 marks. Group B will contain descriptive type seven questions of sixteen marks each, out of which any four are to answer.

*Note: There may be subdivisions in each question asked in End Semester Examinations.*

**UNIT I**

$\mathbb{R}$ ,  $\mathbb{R}^2$ ,  $\mathbb{R}^3$  as vector spaces over  $\mathbb{R}$ . Standard basis for each of them. Concept of Linear Independence and examples of different bases. Subspaces of  $\mathbb{R}^2$ ,  $\mathbb{R}^3$ .

(1 Questions)

Translation, Dilation, Rotation, Reflection in a point, line and plane. Matrix form of basic geometric transformations. Interpretation of eigen values and eigen vectors for such transformations and eigen spaces as invariant subspaces.

(1 Questions)



**UNIT II**

Types of matrices. Rank of a matrix. Invariance of rank under elementary transformations. Reduction to normal form, Solutions of linear homogeneous and non-homogeneous equations with number of equations and unknowns up to four. (3 Questions)

**UNIT III**

Matrices in diagonal form. Reduction to diagonal form upto matrices of order 3. Computation of matrix inverses using elementary row operations. Rank of matrix. Solutions of a system of linear equations using matrices. Illustrative examples of above concepts from Geometry, Physics, Chemistry, Combinatorics and Statistics. (3 Questions)

**Books Recommended**

1. A.I. Kostrikin, *Introduction to Algebra*, Springer Verlag, 1984.
2. S. H. Friedberg, A. L. Insel and L. E. Spence, *Linear Algebra*, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
3. Richard Bronson, *Theory and Problems of Matrix Operations*, Tata McGraw Hill, 1989.

**OR****MAT-G-DSE-502A-T: Mechanics**

(06 Credits, 60 Lectures &amp; 15 Tutorials)

Marks: 20 (MSE: 1Hr) + 80 (ESE: 3Hrs) = 100	Pass Marks (MSE: 8 + ESE: 32) = 40
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**Instruction to Question Setter for:****Mid Semester Examination (MSE):**

*There will be two group of questions. Group A is compulsory and will contain five questions of very short answer type consisting of 1 mark each. Group B will contain descriptive type five questions of five marks each, out of which any three are to answer.*

**End Semester Examination (ESE):**

*There will be two group of questions. Group A is compulsory and will contain two questions. Question No.1 will be very short answer type consisting of eight questions of 1 mark each. Question No.2 will be short answer type consisting two question of 4 marks. Group B will contain descriptive type seven questions of sixteen marks each, out of which any four are to answer.*

*Note: There may be subdivisions in each question asked in End Semester Examinations.*

**UNIT I**

Conditions of equilibrium of a particle and of coplanar forces acting on a rigid Body, Laws of friction, Problems of equilibrium under forces including friction, Centre of gravity, Work and potential energy. (4 Questions)

**UNIT II**

Velocity and acceleration of a particle along a curve: radial and transverse components (plane curve), tangential and normal components (space curve), Newton's Laws of motion, Simple harmonic motion, Simple Pendulum, Projectile Motion. (4 Questions)

**Books Recommended**

1. A.S. Ramsay, *Statics*, CBS Publishers and Distributors (Indian Reprint), 1998.
2. A.P. Roberts, *Statics and Dynamics with Background in Mathematics*, Cambridge University Press, 2003.

OR

**MAT-G-DSE-503A-T: Numerical Methods** (06 Credits, 60 Lectures & 15 Tutorials)

Marks: 20 (MSE: 1Hr) + 80 (ESE: 3Hrs) = 100 Pass Marks (MSE: 8 + ESE: 32) = 40

**Instruction to Question Setter for:****Mid Semester Examination (MSE):**

*There will be two group of questions. Group A is compulsory and will contain five questions of very short answer type consisting of 1 mark each. Group B will contain descriptive type five questions of five marks each, out of which any three are to answer.*

**End Semester Examination (ESE):**

*There will be two group of questions. Group A is compulsory and will contain two questions. Question No.1 will be very short answer type consisting of eight questions of 1 mark each. Question No.2 will be short answer type consisting two question of 4 marks. Group B will contain descriptive type seven questions of sixteen marks each, out of which any four are to answer.*

*Note: There may be subdivisions in each question asked in End Semester Examinations.*

**UNIT I**

Algorithms, Convergence, Bisection method, False position method, Fixed point iteration method, Newton's method, Secant method, LU decomposition, Gauss-Jacobi, Gauss-Siedel and SOR iterative methods.

(4 Questions)

**UNIT II**

Lagrange and Newton interpolation: linear and higher order, finite difference operators. Numerical differentiation: forward difference, backward difference and central Difference. Integration: trapezoidal rule, Simpson's rule, Euler's method.

(4 Questions)

**Recommended Books**

1. B. Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 5th Ed., New age International Publisher, India, 2007.

**SEMESTER VI****Skill Enhancement Course (SEC)**

02 Credit - Theory: 30 Lectures

Full Marks: 10 (MSE: ½ Hrs) + 40 (ESE: 1½ Hrs) = 50

Pass Marks: (MSE: 4) + (ESE: 16) = 20

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**Theory: 30 Lectures**



**Instruction to Question Setter for End Semester Examination (ESE):** There will be two groups of questions. Five Questions to be answered out of Nine Questions. Group A is compulsory and will contain two questions. Question No.1 (A) will be MCQ of 1 mark each (four questions). Question No.1 (B) will be short answer type to be answered in about 50 words of 2 marks (2 Questions). Group B will contain descriptive type eight questions of eight marks each, out of which any four are to answer. Each question carries 08 marks.

**MAT-G-DSE-601B-T: Complex Analysis** (06 Credits, 60 Lectures & 15 Tutorials)

Marks: 20 (MSE: 1Hr) + 80 (ESE: 3Hrs) = 100 Pass Marks (MSE: 8 + ESE: 32) = 40

**Instruction to Question Setter for:**

**Mid Semester Examination (MSE):**

There will be two group of questions. Group A is compulsory and will contain five questions of very short answer type consisting of 1 mark each. Group B will contain descriptive type five questions of five marks each, out of which any three are to answer.

**End Semester Examination (ESE):**

There will be two group of questions. Group A is compulsory and will contain two questions. Question No.1 will be very short answer type consisting of eight questions of 1 mark each. Question No.2 will be short answer type consisting two question of 4 marks. Group B will contain descriptive type seven questions of sixteen marks each, out of which any four are to answer.

*Note: There may be subdivisions in each question asked in End Semester Examinations.*

**UNIT I**

Limits, Limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability. (4 Questions)

**UNIT II**

Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, (2 Questions)

**UNIT III**

Bilinear transformation, conformal mapping, cross ratio and its invariency. (2 Questions)

**Books Recommended**

1. James Ward Brown and Ruel V. Churchill, *Complex Variables and Applications*, 8th Ed., McGraw – Hill International Edition, 2009.
2. Joseph Bak and Donald J. Newman, *Complex analysis*, 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., New York, 1997.

**OR**

**MAT-G-DSE-602B-T: Linear Programming** (06 Credits, 60 Lectures & 15 Tutorials)

Marks: 20 (MSE: 1Hr) + 80 (ESE: 3Hrs) = 100 Pass Marks (MSE: 8 + ESE: 32) = 40



**Instruction to Question Setter for:****Mid Semester Examination (MSE):**

*There will be two group of questions. Group A is compulsory and will contain five questions of very short answer type consisting of 1 mark each. Group B will contain descriptive type five questions of five marks each, out of which any three are to answer.*

**End Semester Examination (ESE):**

*There will be two group of questions. Group A is compulsory and will contain two questions. Question No.1 will be very short answer type consisting of eight questions of 1 mark each. Question No.2 will be short answer type consisting two question of 4 marks. Group B will contain descriptive type seven questions of sixteen marks each, out of which any four are to answer.*

*Note: There may be subdivisions in each question asked in End Semester Examinations.*

**UNIT I**

Linear Programming Problems, Graphical Approach for Solving some Linear Programs. Convex Sets, Supporting and Separating Hyperplanes. Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method, Big-M method and their comparison. (5 Questions)

**UNIT II**

Duality, formulation of the dual problem, primal- dual relationships, economic interpretation of the dual, sensitivity analysis. (3 Questions)

**Recommended Books**

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear programming and Network Flows*, 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, *Introduction to Operations Research*, 8th Ed., Tata McGraw Hill, Singapore, 2004.
3. Hamdy A. Taha, *Operations Research, An Introduction*, 8th Ed., Prentice-Hall India, 2006.

**OR**

**MAT-G-DSE-603B-T: Linear Algebra** (06 Credits, 60 Lectures & 15 Tutorials)

Marks: 20 (MSE: 1Hr) + 80 (ESE: 3Hrs) = 100 Pass Marks (MSE: 8 + ESE: 32) = 40

**Instruction to Question Setter for:****Mid Semester Examination (MSE):**

*There will be two group of questions. Group A is compulsory and will contain five questions of very short answer type consisting of 1 mark each. Group B will contain descriptive type five questions of five marks each, out of which any three are to answer.*

**End Semester Examination (ESE):**

*There will be two group of questions. Group A is compulsory and will contain two questions.*

**Question No.1 will be very short answer type consisting of eight questions of 1 mark each. Question No.2 will be short answer type consisting two question of 4 marks. Group B will contain descriptive type seven questions of sixteen marks each, out of which any four are to answer.**

**Note:** There may be subdivisions in each question asked in End Semester Examinations.

### UNIT I

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces. (3 Questions)

### UNIT II

Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations. Dual Space, Dual Basis, Double Dual, Eigen values and Eigen vectors, Characteristic Polynomial. (3 Questions)

### UNIT III

Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix. (2 Questions)

### Books Recommended

1. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra*, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
  2. David C. Lay, *Linear Algebra and its Applications*, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
  3. S. Lang, *Introduction to Linear Algebra*, 2nd Ed., Springer, 2005.
  4. Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007.
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Format of question Papers of End-Semester Theory Examination

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Binod Bihari Mahto Koyalanchal University, Dhanbad  
End-Semester Examination xxxx (Session: xxxx-xx)

Subject/Code:

Full Marks: 80

Pass Marks: 32

Time: 3 Hours

**General Instructions:**

Candidates are required to give their answers in their own words as far as practicable.

The Questions are of equal value.

Answer any five questions of the following in which Q.1 is compulsory.

**Group A**

1. (A) Multiple Choice Questions

(1x8=08)

- (i) .....
- (ii) .....
- (iii) .....
- (iv) .....
- (v) .....
- (vi) .....
- (vii) .....
- (viii) .....

(B) Short answer type questions

(4x2=08)

- (a) .....
- (b) .....

**Group B**

(Long answer type questions)

Answer any four of the following.

(16x4=64)

- 2. ....
- 3. ....
- 4. ....
- 5. ....
- 6. ....
- 7. ....
- 8. ....

.....X.....

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**Binod Bihari Mahto Koyalanchal University, Dhanbad**  
**End-Semester Examination ~~xxxx~~ (Session: ~~xxxx-xx~~)**

Full Marks: 40

Subject/Code:

Pass Marks: 16

Time: 1½ Hours

**General Instructions:**

Candidates are required to give their answers in their own words as far as practicable.  
The Questions are of equal value.

Answer any five questions of the following in which Q.1 is compulsory.

**Group A**

1. (A) Multiple Choice Questions

(1x4=04)

- (i) .....
- (ii) .....
- (iii) .....
- (iv) .....
- (v) .....
- (vi) .....

(B) Short answer type questions

(2x2=04)

- (a) .....
- (b) .....

**Group B**

(Long answer type questions)

Answer any four of the following.

(8x4=32)

- 2. ....
- 3. ....
- 4. ....
- 5. ....
- 6. ....
- 7. ....
- 8. ....