

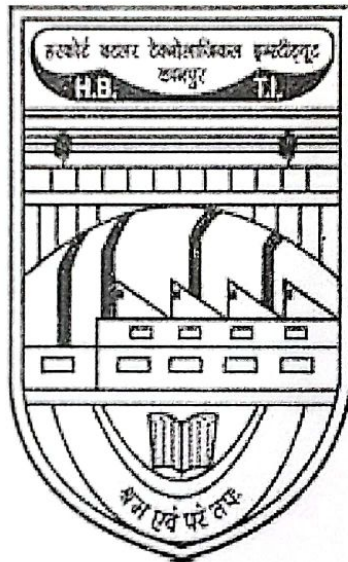
# Course Structure and Evaluation Scheme

SYLLABI

(First and Second Year)

**BS-MS Program**

(Mathematics and Data Science)



**Department of Mathematics**

**School of Basic and Applied Sciences**

**Harcourt Butler Technical University**

**Kanpur-02**

**(III BOS Meeting Held on 29.02.2024)**

**Department of Mathematics**  
**School of Basic and Applied Sciences**  
**H.B.T.U. Kanpur**

**MINUTES of Third meeting of the Board of Studies-Mathematics**

Venue: Department of Mathematics, Mode of Meeting: Hybrid Mode

Date & Time: 29.02.2024 & 3:00 PM

Google Meet Link: <https://meet.google.com/dsf-eyyk-ywk>

Third Meeting of the Board of Studies was held to consider and approve the syllabi of the courses of study for first year and second year students of **BS-MS (Mathematics and Data Science) program and BBA & MBA programs.**

The following members attended the meeting.

1. Prof. Ram Autar	Chairman, BOS	
2. Prof. B. V. Rathish Kumar	Member	IIT Kanpur
3. Prof. Neeraj Mishra	Member	IIT Kanpur
4. Prof. H. C. Taneja	Member	DTU, New Delhi
5. Prof. V. K. Katiyar	Member	IIT Roorkee
*6. Prof. Yaduvir Singh	Member	EE Deptt.
*7. Prof. D. Parmar	Member	CE Deptt.
8. Prof. Anita Yadav	Member	CSE Deptt.
9. Prof. Rekha Bali	Member	Maths Deptt.
10. Prof. Ram Naresh	Member	Maths Deptt.
11. Dr. Udaya Pratap Singh	Member	Maths Deptt.
12. Dr. Shivam Shreevastava	Member	Maths Deptt.

\* could not participate in the meeting.

After welcoming the honorable members in the BOS meeting, the syllabi of various courses of study for **first** year and **second** year students of **BS-MS (Mathematics and Data Science) program and BBA & MBA programs**, the lists of examiners and papers setters were presented for their consideration and approval. A thorough discussion took place and following decisions were taken:

- The syllabi of various courses of study for **first** year and **second** year students of **BS-MS (Mathematics and Data Science) program and BBA & MBA programs** were approved.
- The course-structure and evaluation scheme for proposed **BS-MS (Mathematics and Data Science) degree Program** was approved.



- The list of examiners and papers setters were approved.
- The suggestions given by the honorable members were entertained and incorporated to improve the syllabi and course-structure.
- The chairman, BOS was authorized to recommend the names of suitable persons for inclusion in the panels of paper setters, examiners, and moderators on behalf of BOS, if required.
- The chairman, BOS, was authorized to make/ introduce minor changes in the syllabus and to modify/ reshuffle/ improve the course-structure as per need/ requirement of the industry brought to notice by stakeholders, if any.

The Meeting ended with a vote of thanks to the chair.

✓ (Prof. B. V. Rathish Kumar)  
Member


✓ (Prof. Neeraj Mishra)  
Member

✓ (Prof. H. C. Taneja)  
Member

✓ (Prof. V. K. Katiyar)  
Member


\* (Prof. Yaduvir Singh)  
Member

\* (Prof. D. Parmar)  
Member

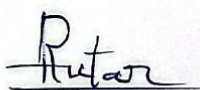
  
(Prof. Anita Yadav)  
Member

  
(Dr. Shivam Shreevastava)  
Member

  
(Dr. U. P. Singh)  
Member

  
(Prof. Ram Naresh)  
Member

  
(Prof. Rekha Bali)  
Member

  
(Prof. Ram Autar)  
Chairman, BOS  
**Dr. Ram Autar**

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✓ participated in the meeting (Online mode).

\* could not participate in the meeting.



# Course Structure and Evaluation Scheme

## BS-MS Program (Mathematics and Data Science)

Semester wise Course Structure and Evaluation Scheme

(With effect from Session 2023-2024)

### Year I, Semester-I

S. No.	Course Type	Course Title	Subject Code *	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	BSC	Engineering Physics	NPH-101	4	3	0	2	15	20	15	50	50	100
2	BSC	Engineering Mathematics-I	NMA-101	4	3	1	0	30	20	-	50	50	100
3	ESC	Introduction to Electrical Engineering	NEE-101	4	3	0	2	15	20	15	50	50	100
4	ESC	Introduction to Mechanical Engineering	NME-101	4	3	1	0	30	20	-	50	50	100
5	HSMC	Professional Communication	NHS-101	4	2	1	2	15	20	15	50	50	100
6	ESC	Engineering Graphics	NCE-103	2	0	0	4	30	20	-	50	50	100
Total Credits: 22												600	

### Year I, Semester-II

S. No.	Course Type	Course Title	Subject Code*	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	BSC	Engineering Chemistry	NCY-102	4	3	0	2	15	20	15	50	50	100
2	ESC	Introduction to Computer Science & Engineering	NCS-102	4	3	1	0	30	20	-	50	50	100
3	ESC	Introduction to Electronics Engineering	NET-102	4	3	1	0	30	20	-	50	50	100
4	ESC	Introduction to Data Science and Analytics	NMA-112	4	3	0	2	15	20	15	50	50	100
5	ESC	Python for Data Science	NMA-114	4	3	0	2	15	20	15	50	50	100
6	ESC	Workshop Practice		2	0	0	4	-	20	30	50	50	100
Total Credits: 22												600	

Remark: The above 44 credit hours will be followed by an exit-credits 10 with skill-enhancement courses of 4 credits and job-specific internship of 6 credits in summer vacation for the award of Certificate after the study of One year.

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Year II, Semester-III

S. No.	Course Type	Course Title	Subject Code *	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	BSC	Engineering Maths-2	NMA-201	4	3	1	0	30	20	-	50	50	100
2	ESC	Data Structures and Algorithms	NMA-211	4	3	0	2	15	20	15	50	50	100
3	PCC	Statistical Methods	NMA-213	4	3	0	2	15	20	15	50	50	100
4	PCC	Probability and Random Processes	NMA-215	4	3	0	2	15	20	15	50	50	100
5	PCC	Real Analysis	NMA-217	3	3	0	0	30	20	-	50	50	100
6	HSMC	Economics & Management	NHS-201	3	3	0	0	30	20	-	50	50	100
7	PCC	Data Science Lab-1	NMA-219	2	0	0	4	-	20	30	50	50	100
<b>Total Credits: 24</b>													<b>700</b>

Year II, Semester- IV

S. No.	Course Type	Course Title	Subject Code*	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	BSC	Engineering Maths-3	NMA-202	4	3	1	0	30	20	-	50	50	100
2	ESC	CONM	NMA-204	4	3	0	2	15	20	15	50	50	100
3	PCC	Numerical Optimization	NMA-212	4	3	0	2	15	20	15	50	50	100
4	PCC	Computational Linear Algebra	NMA-214	4	3	0	2	15	20	15	50	50	100
5	PCC	Discrete Mathematical Structures	NMA-216	3	3	0	0	30	20	-	50	50	100
6	PCC	R for Data Science	NMA-218	3	2	0	2	15	20	15	50	50	100
7	PCC	Data Science Lab-2	NMA-220	2	0	0	4	-	20	30	50	50	100
<b>Total Credits: 24</b>													<b>700</b>

**Remark:** The above 92 credit hours will be followed by an exit-credits 10 with skill-enhancement courses of 4 credits and job-specific internship of 6 credits in Summer Vacation for the award of Diploma after the study of Two years.

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## Detailed Syllabus

### Year I, Semester I

#### ENGINEERING PHYSICS

NPH-101/102

L-T-P-C: 3-0-2- 4

#### Course Objective:

The objective of the course is to understand the basic concepts of nature around us and to synthesize the knowledge from different areas of physics for analysing and solving various critical problems.

#### Course Outcomes (COs):

On successful completion of the course, the students will be able to:

CO1	Understand and apply the principle of conservation of momentum, the theory of relativity.	K2, K1
CO2	Understand the basics of quantum mechanics and apply its principles to learn the phenomenon that occurs at subatomic dimensions.	K3, K1
CO3	Understand Maxwell's equations of electromagnetic theory with the aim to apply them in a communication system.	K5, K1
CO4	Apply the fundamentals of material science, especially to dielectric materials, semiconducting materials, nano- materials, and Superconducting Materials.	K2, K1
CO5	Understand the statistical behavior of the constituent particles and apply the principles of statistical mechanics in the formation of materials and basics of LASERS	K4, K1

K1-Remember, K2- Understand, K3-Apply, K4-Analyse, K5-Evaluate, K6-Create

#### Course Articulation Matrix (CO-PO Matrix)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	2	1	2	-	-	-	-	-	3
CO2	3	3	1	2	1	2	-	-	-	-	-	3
CO3	3	3	1	2	1	2	-	-	-	-	-	3
CO4	3	3	3	2	1	3	3	-	-	-	-	3
CO5	3	3	2	3	3	3	-	-	-	-	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) if there is no correlation put“-”.



## Course Content

### UNIT- 1

Relativistic Mechanics:

Inertial and Non- Inertial Frames of references, Galilean transformation equations, Michelson Morley Experiment, Lorentz Transformation equations, Length contraction, Time dilation and its experimental evidence, Relativistic velocity addition formula, Relativistic variation of mass with velocity, Evidence of variation of mass with velocity, Einstein's Mass-Energy equivalence, examples from nuclear physics, Relativistic energy momentum relation.

### UNIT- 2

Quantum Mechanics:

Dual nature of matter & radiation, Heisenberg's uncertainty Principle and their applications, wave packet concept, Davisson-Germer experiment, Postulates of quantum mechanics, Significance of wave function, Derivation of Schrodinger equation for time independent and time dependent cases. Applications of Schrodinger wave equation for a free particle, Particle in a box (one dimensional and three dimensional cases), Simple harmonic oscillator (one dimensional case).

### UNIT- 3

Electromagnetic Theory:

Ampere's law and Faraday's law of electromagnetic induction, Derivation of Maxwell's equations and their physical significance, Correction of Ampere's law by Maxwell, Concept of displacement current, Poynting theorem, Maxwell's equations in free space & velocity of electromagnetic waves, Transverse character of the wave and orthogonality of  $\mathbf{E}$ ,  $\mathbf{H}$  and  $\mathbf{k}$  vectors, Maxwell's equation in dielectric medium and velocity of e.m. wave, Comparison with free space, Maxwell's equations in conducting media & solution of differential equation in this case, penetration depth & its significance.

### UNIT- 4

Statistical Mechanics & Lasers:

Macrostates and Microstates, Phase space, probability of distribution, most probable distribution, Maxwell-Boltzmann Statistics, Applications of Maxwell-Boltzmann Statistics, derivation of average velocity, RMS velocity and most probable velocity in the above cases, Bose-Einstein Statistics & its application in case of black body radiation, distribution law of energy, Planck's radiation formula, derivation of Wien's law, Rayleigh-Jeans law and Stefan's law from Planck's radiation formula. Fermi - Dirac statistics, application in case of free electrons in metals, energy distribution, Fermi energy.

Lasers: Spontaneous and stimulated emission of radiations, Einstein's theory of matter-radiation interaction, Einstein's coefficients and relation between them, Population inversion, components of a

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laser, different kinds of lasers, Ruby laser, He-Ne laser, solid state lasers, properties of laser beams, mono-chromaticity, coherence, directionality and brightness, applications of lasers in various technological applications.

## UNIT- 5

### Materials of Technological Importance:

**Dielectric Materials:** Electric field in presence of dielectric medium, concept of electric polarization, different types of polarizations, behavior of dielectric in a.c. field, concept of dielectric loss and loss energy and their importance.

**Semiconducting Materials:** Concept of energy bands in solids, carrier concentration and conductivity in intrinsic semiconductors and their temperature dependence, carrier concentration and conductivity in extrinsic semiconductors and their temperature dependence, Hall effect in semiconductors, compound semiconductors, amorphous semiconductors.

**Nano Materials:** Basic principles of nanoscience and technology, preparation, structure and properties of fullerene and carbon nano tubes, applications of nanotechnology.

**Superconducting Materials:** Resistivity and susceptibility of Superconductors, Type – I and Type –II superconductors, Meissner effect, Low temperature Superconductors, Organic Superconductors, Oxide Superconductors, High temperature Superconductors, BCS theory (Qualitative).

### Text Books:

1. Engineering Physics, R.K. Shukla, Pearson Education, Vol.-II, 2014
2. Electrical Engineering Materials, R.K. Shukla, McGraw Hill, 1<sup>st</sup> Edition, 2012
3. Principles of Engineering Physics, R.K. Shukla, Ira Books, 1<sup>st</sup> Edition, 2011
4. Engineering Physics –I & II, S.K. Gupta, Krishna Prakashan Media (P) Ltd., 2014

### References Books:

1. Fundamental university physics, Vol. - I: Mechanics, Marcelo Alonso, J. Finn Edwards, Addison-Wesley, 1<sup>st</sup> Edition, 1967
2. Concepts of Modern Physics, Arthur Beiser, McGraw Hill, 6<sup>th</sup> Edition, 2003
3. Introduction to Electrodynamics, David Griffiths, Cambridge University Press, 4<sup>th</sup> Edition, 2017
4. Introduction to Solid State Physics, Charles Kittel, Wiley, 8<sup>th</sup> Edition, 2005
5. Introduction to Nanotechnology, Charles P. Poole Jr., Frank J. Owens, Wiley-Interscience, 1<sup>st</sup> Edition, 2003

### Web Links:

1. <https://nptel.ac.in/courses/122101002> [IIT Bombay, Prof. D.K. Ghosh]
2. <https://nptel.ac.in/courses/122103011> [IIT Guwahati, Prof. Alike Khare, Prof. Pratima Agarwal, Prof. S. Ravi]
3. <https://nptel.ac.in/courses/115105099> [IIT Kharagpur, Prof. Amal Kumar Das]
4. <https://nptel.ac.in/courses/115101005> [IIT Bombay, Prof. D.K. Ghosh]
5. <https://nptel.ac.in/courses/115106066> [IIT Madras, Prof. S. Lakshmi Bala]

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# ENGINEERING MATHEMATICS-I

NMA-101/102

L-T-P-C: 3-1-0-4

**OBJECTIVE:** The objective of this course is to educate the students about:

- The convergence of infinite series, improper integrals and differential calculus.
- Partial differentiation, multiple integrals and Beta, Gamma functions.

### Course Outcome

On the successful completion of the course, students will be able to

CO1	Find nth derivative, determine the expansion of functions and find convergence of series and improper integrals.	Understand, Apply
CO2	Find partial differentiation and evaluate area and volume using multiple integrals.	Apply, Evaluate
CO3	Convert line integrals to surface integrals and volume integrals, determine potential functions for irrotational force fields.	Apply, Evaluate
CO4	Solve linear system of equations and determine the eigenvectors of the matrix.	Apply, Analyse, Evaluate,
CO5	Learn concept of optimization and optimization techniques.	Apply, Analyse, Evaluate,

### Course Articulation Matrix (CO-PO Matrix)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	-	-	1	-	1	-	3
CO2	3	3	2	1	2	-	-	1	-	1	-	3
CO3	3	3	2	1	2	-	-	1	-	1	-	3
CO4	3	3	2	1	2	-	-	1	-	1	-	3
CO5	3	3	2	1	2	-	-	1	-	1	-	3
Average	3	3	2	1	2	-	-	1	-	1	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) if there is no correlation, put“-“

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## Detailed Syllabus

### Unit I-Functions of One Real Variable

Successive differentiation, Leibnitz theorem, Mean value theorems, sequences and series, Expansion of functions, Improper integrals and their convergence.

### Unit II-Functions of Several Real Variables

Limit, Continuity, Partial differentiation, Total differential and approximations, Jacobian, Euler's theorem Expansion of functions, Beta and Gamma Functions, Multiple integral, Change of order, Change of variables, Applications to area, volume, mass, surface area etc. Dirichlet's Integral & applications.

### Unit III-Vector Calculus

Point functions, differentiation, Differential Operators: Gradient, Laplacian, Hessian, Directional derivative, Divergence and Curl of a vector and their physical interpretations, Solenoidal & irrotational fields, Integration, Line, Surface and Volume integrals Green's, Stoke's and Gauss Divergence theorems (without proof) and applications.

### Unit IV-Matrices and Linear Algebra

Vector space and subspace, linear dependence, dimensions and basis, Linear transformation and its matrix representation, Elementary transformations, Echelon form, rank & nullity, Consistency of linear system of equations and their solutions, characteristic equation, Cayley Hamilton theorem, Real and complex eigen values and eigenvectors, diagonalisation, quadratic forms, complex, orthogonal, and unitary matrices, Application to Cryptography, discrete, Compartmental models and system stability.

### Unit V-Optimization

Engineering applications of optimization, statement and classification of optimization problems, Optimization techniques, single variable optimization, multivariable optimization with no constraint, with equality and inequality constraints, Linear Programming Problems, Graphical method and Simplex method.

### Books Recommended:

1. R.K. Jain & S.R.K. Iyengar; Advanced Engineering Mathematics, Narosa Publishing House 2002.
2. Erwin Kreyszig; Advanced Engineering Mathematics. John Wiley & Sons 8<sup>th</sup> Edition.
3. Dennis G.Zill & Michael R.Cullen; Advanced Engineering Mathematics, Jones & Bartlett Publishers, 2<sup>nd</sup> Edition.
4. S.S. Rao; Optimization: Theory & Applications Wiley Eastern Limited.
5. T.M. Apostol, Calculus, Vol.II, 2<sup>nd</sup> ed., Wiley 1969.
6. Gilbert Strang, Linear Algebra & its applications, Nelson Engineering 2007.
7. Thomas and Finny "Calculus & Analytic Geometry".

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# INTRODUCTION TO ELECTRICAL ENGINEERING

L-T-P-C: 3-0-2-4

NEE-101/102

## Course Objectives

The goal of the course is to make the students understand the basic principles of electrical engineering.

## Course Outcomes

At the end of the course the students will be able to:

- CO1. apply Mesh and Nodal Methods of Analysis and Network Theorem in DC Network.
- CO2. understand and analyze the ac circuit and calculate the various parameters.
- CO3. understand and analyze the 3-phase connections of source and load, and, measurement of 3-phase power.
- CO4. understand the magnetic circuit with working & applications and to calculate the various parameters of magnetic circuits and transformer efficiency.
- CO5. understand the basic principles of AC & DC Machines

## Course Articulation Matrix (CO-PO Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3		2		1					2		2
CO2	3	1			1					2		2
CO3	3			3	1					2		2
CO4	3				1					2		2
CO5	3		2		1					2		2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation put "-".

## Course Content

### UNIT 1 - DC Circuit Analysis and Network Theorems

Circuit Concepts: Concepts of Network, Active and Passive elements, voltage and current sources, concept of linearity and linear network, unilateral and bilateral elements. R L and C as linear elements. Source Transformation. Kirchhoff's Law, loop and nodal methods of analysis; star - delta transformation; Network Theorems: Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem. (Simple Numerical Problems)

### UNIT 2 - Steady State Analysis of Single Phase AC Circuits

Sinusoidal, Square and Triangular waveforms - average and effective values, form and peak factors, concept of phasors, phasor representation of sinusoidally varying voltage and current.

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Analysis of series, parallel, and series – parallel RLC Circuits: Apparent, Active & Reactive Powers, Power factor, causes and problems of low power factor, power factor improvement. Resonance in Series and Parallel Circuits. (Simple Numerical Problems)

### UNIT 3 - Three Phase AC Circuits

Three Phase System – its necessity and advantages, meaning of phase sequence and star and delta connections, balanced supply and balanced load, line and phase voltage / current relations, three phase power and its measurement. (Simple Numerical Problems)

### UNIT 4 - Magnetic Circuits and Transformer

Magnetic Circuit: Magnetic circuit concepts, analogy between Electric & Magnetic circuits, Magnetic circuits with DC and AC excitations, Magnetic leakage, B-H curve, Hysteresis and Eddy Current losses, Magnetic circuit calculations.

Single Phase Transformer: Principle of Operation, Construction, e.m.f. equation, Power losses, efficiency. (Simple Numerical Problems)

### UNIT 5 - Electro Mechanical Energy Conversion

Basic Principles of electro mechanical energy conversion.

DC Machines: Types of DC machines, e.m.f. equation of generator and torque equation of motor, Speed-Torque characteristics of DC Series and Shunt Motors, Applications of dc motors. (Simple Numerical Problems).

Three Phase Induction Motor: Types, Principle of Operation, Slip – torque Characteristics, applications. (Simple Numerical Problems).

Single Phase Induction Motor: Basic Principles of 1-phase Induction Motor and its applications

Three Phase Synchronous Machines: Principle of Operation of alternator and synchronous motor and their applications.

### List of Experiments

1. Verification of Kirchhoff's laws.
2. Verification of Superposition Theorem.
3. Verification of Thevenin's Theorem.
4. Verification of Maximum Power Transfer Theorem.
5. Measurement of power and power factor in a 1 –  $\emptyset$  ac series inductive circuit and study improvement of power factor using capacitor.
6. Study of phenomenon of resonance in RLC series circuit and obtain the resonant frequency.
7. Measurement of power in 3 –  $\emptyset$  circuit by Two Wattmeter method and determination of its power factor.
8. Determination of parameter of ac 1 –  $\emptyset$  series RLC Circuit.



9. Determination of Efficiency by load test of a 1 –  $\emptyset$  Transformer.
10. To study running and speed reversal of a 3 –  $\emptyset$  induction motor and record its speed in both direction.

**Note:**

- a. Department may add any three experiments in the above list.
- b. Minimum eight experiments are to be performed out of the above list.

**Text books:**

1. V. Del Toro, "Principles of Electrical Engineering" Prentice Hall International
2. I. J. Nagarath, "Basic Electrical Engineering" Tata Mc - Graw Hill
3. D. E. Fitzgerald & A. Grabel Higginbotham, "Basic Electrical Engineering" Mc - Graw Hill
4. B. L. Theraja and A. K. Theraja, "Basic Electrical Engineering: July 1999.

**Reference books:**

1. Edward Hughes, "Electrical Technology" Longman
2. T. K. Nagsarkar & M. S. Sukhija, "Basic Electrical Engineering" Oxford University Press
3. H. Cotton, "Advanced Electrical Technology" Wheeler Publishing
4. W. H. Hayt & J. E. Kennely, "Engineering Circuit Analysis" McGraw Hill

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# INTRODUCTION TO MECHANICAL ENGINEERING

**NME-101/102:**

**L-T-P-C: 3-1-0-4**

**Course Objectives:**

To explain the basic fundamentals of forces, moments, stresses, strains, fundamental of fluid and fluid flow application, fundamentals of thermodynamics and mode of heat transfers.

**Course Outcomes (CO):**

At the end of this course students should be able to:

CO1	Understand the basic laws concepts of mechanical systems.	K2, K1
CO2	Determine resultants and apply conditions of static equilibrium to plane force systems.	K3, K1
CO3	Analyze beam for shear force and bending moment along the span and analyze trusses for axial forces.	K4, K1
CO4	Evaluate the structural properties centroid and moment of inertia	K5, K1
CO5	Stress analysis for one- and two-dimensional stress systems.	K3, K1

K1- Remember, K2- Understand, K3-Apply, K4-Analyse, K5- Evaluate, K6- Create

**Course Articulation Matrix (CO-PO Matrix)**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3			1	1	1	1	1		1
CO2	3	3	3									1
CO3	3	3	3									1
CO4		3	2	2								1
CO5		3	2	2								1

1: Slight(Low) 2:Moderate(Medium) 3:Substantial(High) If there is no correlation put“-”.

**Course Content:**

**UNIT-1: Fundamental Concepts and Definitions:**

**Mechanical Engineering: Scope and expanse**

Concept of machines and mechanisms, classification of machines. Thermodynamic systems, Laws of thermodynamics. Introduction to modes of heat transfer, applications. Materials, classification, selection of materials in design of components. Manufacturing processes, mechanical working of metals.

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## UNIT-2:

**Two-Dimensional Force Systems:** Basic concepts, laws of motion, Principle of transmissibility of forces, transfer of a force to parallel position, resultant of a force system, simplest resultant of two dimensional concurrent and non-concurrent force systems, distributed force system, free body diagrams, equilibrium and equations of equilibrium, applications.

**Friction:** Introduction, Laws of Coulomb friction, Equilibrium of bodies involving dry-friction, belt friction, applications.

## UNIT-3:

**Beam:** Introduction, Shear force and bending moment, differential equations for equilibrium, shear force and bending moment diagrams for statically determinate beams.

**Trusses:** Introduction, simple truss and solution of simple truss, Method of joints and method of sections.

**UNIT-4: Centroid and Moment of Inertia:** Centroid of plane, curve, area, volume and composite bodies, Moment of inertia of plane area, Parallel Axes theorem, Perpendicular axes theorems, Principal moment of inertia, mass moment of inertia of circular ring, disc, cylinder, sphere and cone about their axis of symmetry.

**UNIT-5: Introduction to Strength of Materials:** Introduction, normal and shear stresses, stress-strain diagrams for ductile and brittle material, elastic constants, One Dimensional loading of members of varying cross-sections, strain-energy, 2D state of plane stress, Principal stresses and strains.

### Text books:

1. Engineering Mechanics by Abhijit Chanda and Debabrata Nag, Wiley India Pvt. Ltd, 2018, Kindle Edition, ISBN: 9788126570935.
2. Engineering Mechanics: Statics by J L Meriam. L G Kraige. Virginia Polytechnic Institute and State University, John Wiley & Sons, 2017. ISBN-978-8126564033.
3. Engineering Mechanics of Solids, Egor P. Popov, PHI Publications, 1990.
4. Theory of Machines and Mechanisms by J.E. Shigley, Oxford University Press, 5<sup>th</sup> Edition, 2017.
5. Engineering Thermodynamics by P K Nag, TMH Publication, 4<sup>th</sup> Edition, 2008.

### Reference Books:

1. Theory of Machines and Mechanisms by Amitabha Ghosh and Asok Kumar Mallick, Affiliated East-West Press, 3<sup>rd</sup> Edition, ISBN: 9788185938936.
2. Engineering Mechanics by Timoshenko S., McGraw-Hill Education – Europe, 5<sup>th</sup> Edition, 2013.
3. Engineering Mechanics by Nelson A, McGraw Hill Education India, 1<sup>st</sup> Edition, ISBN-978-0070146143, 2017

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4. Materials and Manufacturing: An Introduction to How they Work and Why it Matters by Mark A Atwater McGraw-Hill Education, 1<sup>st</sup> Edition, ISBN: 9781260122312, 2018
5. Engineering Thermodynamics: Work and Heat Transfer by Rogers, Pearson Education India, 4<sup>th</sup> Edition, 2002.

**Web Links:**

- 1- <https://nptel.ac.in/courses/112106286> [ IIT Madras, Prof. K. Ramesh]
- 2- <https://nptel.ac.in/courses/112103108> [IIT Guwahati, Prof. US Dixit]
- 3- <https://nptel.ac.in/courses/112103109> [IIT Guwahati, Prof. US Dixit]
- 4- <https://eng.utq.edu.iq/wp-content/uploads/sites/4/2019/09/engineering-mechanics-lectures.pdf>[Thi-Qar University, Prof. Haider]
- 5- [https://www.youtube.com/watch?v=tisNUzd\\_fIM&t=96s](https://www.youtube.com/watch?v=tisNUzd_fIM&t=96s) [Dr. V. P. Singh, HBTU, Kanpur]
- 6- <https://www.youtube.com/watch?v=a6RNss9kBuI&t=11s> [Dr. V. P. Singh, HBTU, Kanpur]
- 7- [https://www.youtube.com/watch?v=LE1Lc6\\_640U](https://www.youtube.com/watch?v=LE1Lc6_640U)[Dr. V. P. Singh, HBTU, Kanpur]

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# PROFESSIONAL COMMUNICATION

**NHS 103 / 104**  
**Course Objectives**

**L-T-P-C: 2-1-2-4**

- Critically think about communication processes and messages.
- Write effectively for a variety of contexts and audiences.
- Interact skillfully and ethically.
- Develop and deliver professional presentations

## Course Outcomes (CO)

At the end of this course students should be able to:

CO1	Effectively communicate their ideas in the contemporary global competitive environment.	K2, K1
CO2	Convey their messages through constructive writing.	K3, K1
CO3	Draft potent E-Mails, letters, proposals and reports.	K4, K1
CO4	Present their presentations along with using all nuances of delivery with clarity and thoroughness.	K5, K1
CO5	Solve problems based on real time situations and articulate them eventually.	K3, K1

K1- Remember, K2- Understand, K3-Apply, K4-Analyse, K5- Evaluate, K6- Create

## Course Articulation Matrix (CO-PO Matrix of selected Course): NHS 103/104

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	0	0	0	0	0	0	0	0	2	3	0	1
CO2	0	0	0	0	0	0	0	0	2	3	0	1
CO3	0	0	0	0	0	0	0	0	2	3	0	1
CO4	0	0	0	0	0	0	0	0	2	3	0	1
CO5	0	0	0	0	0	0	0	0	2	3	0	1

1:Slight(Low) 2:Moderate(Medium) 3:Substantial(High) if there is no correlation put“-”.

## UNIT I

### Fundamentals of Technical Communication

Process of communication, language as a tool of communication, levels of communication, flow of communication, barriers to communication, communication across cultures; Technical Communication: meaning, significance, characteristics, difference between technical and general communication.

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## UNIT II

### Elements of Written Communication

Words and phrases, word formation, synonyms and antonyms, homophones, one word substitution, sentence construction, paragraph construction,

## UNIT III

### Forms of Technical Communication

(A) business letters, job application letter and resume, 7C's of letter writing, business letters: sales & credit letters, letters of enquiry, letters of quotation, order, claim and adjustment letters, official letters: D.O. letters, government letters, letters to authorities, etc. ,

(B) Technical Reports: general format of a report, formal and informal reports, memo report, progress report, status report, survey report, trip report, complaint report, , Joining Report ,laboratory report, research papers, dissertations and theses. E-mail writing Technical Proposals: purpose, characteristics, types, structure

## UNIT IV

### Presentation Strategies

Defining the subject, scope and purpose, analyzing audience & locale, collecting materials, preparing outlines, organizing the contents. Pre-presentation strategies, during presentation strategies, nuances of delivery, verbal and non-verbal communication, Body language, paralinguistic features of voice, visual aids.

## UNIT V

### Value-based Text Reading

(A) Study of the following essays from the text book with emphasis on writing skills:

- |                                           |                     |
|-------------------------------------------|---------------------|
| 1. Man and Nature                         | by J. Bronowski     |
| 2. The Language of Literature and Science | by Aldous Huxley    |
| 3. The Aims of Science &The Humanities    | by Moody E Prior    |
| 4. Gods in this Godless Universe          | by Bertrand Russell |
| 5. Science and Survival                   | by Barry Commoner   |

(B) Readings of selected short stories:

- |                             |                        |
|-----------------------------|------------------------|
| 1. The Renunciation         | by Rabindranath Tagore |
| 2. The Lament               | by Anton P. Chekhov    |
| 3. The Barber's Trade Union | by Mulk Raj Anand      |
| 4. The Eyes Are Not Here    | by Ruskin Bond         |

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## Professional Communication Laboratory

Interactive practical sessions with emphasis on oral presentations / spoken communication:

Practical Sessions on:

1. Group Discussions: selected topical issues to be discussed in groups.
2. Mock interviews
3. Communication skills for seminars/conferences/workshops with emphasis on non-verbal skills.
4. Presentation skills for technical papers/project reports/professional reports.
5. Theme presentation/ key note presentation based on correct argumentation methodologies.
6. Argumentative skills
7. Role play
8. Comprehension skills based on reading and listening practice, asking questions.
9. Introduction to International Phonetics Alphabets
10. Audio Visual demonstration of effective communicative strategies & TED Talks

### Text Books

1. Improve Your Writing Edited By V N Arora and Laxmi Chandra, Oxford University Press, First Edition, New Delhi, 2013.
2. An Anthology of English Short Stories, Edited by R P Singh, First Edition, 2015, Oxford University Press.
3. Technical Communication- Principles and Practices by Meenakshi Raman & Sangeeta Sharma, Third Edition, 2015, Oxford University Press, New Delhi.
4. Sethi and Dhamija, 'A Course in Phonetics and Spoken English', Second Edition, 2004, Prentice Hall of India, New Delhi.
5. Joans Daniel, 'English Pronouncing Dictionary', 18th Edition, 2011, Cambridge University Press.

### Reference Books

1. Effective Technical Communication, by Barun K Mitra, First Edition, 2008, Oxford University Press.
2. Business Correspondence & Report Writing by R.C. Sharma & Krishna Mohan, Fifth Edition, 2017, Tata McGraw Hill, N.D.
3. Developing Communication Skills by Krishna Mohan & Meera Banerjee, Second Edition, 2000, Macmillan India
4. Technical Communication-Principles and Practices by M R S Sharma, Third Edition, 2015, Oxford University Press, New Delhi
5. R. K. Bansal & J.B. Harrison, Spoken English for India, Orient Longman, Fourth Edition, 2013, Orient Blackswan, Hyderabad.
6. Excellence in Business Communication, 13th Edition, 2020 Publisher-Pearson Education.

### Web Links:

1. <https://nptel.ac.in/courses/109104030> [ Dr. T Ravichandran, IIT Kanpur]

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# ENGINEERING GRAPHICS

NCE-103/104

L-T-P-C: 0-0-4-2

## Course Outcomes

At the end of this course, students should be able:

CO1	To understand and apply the concepts of lettering, dimensioning, scales and geometric construction
CO2	To visualize the position and location of any point, line, plane, or surface and draw their orthographic projections
CO3	To visualize and draw/develop the true shape, size, and sections of solid objects the true shape, size, and specifications of physical objects
CO4	To apply the visualization skill, to draw a simple isometric and perspective projections
CO5	To understand and draw basic civil Engineering building components using AutoCAD

## Course Articulation Matrix (CO-PO Matrix)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	1	2	-	-
CO2	2	-	-	-	-	-	-	-	1	2	-	-
CO3	2	-	-	-	-	-	-	-	1	2	-	-
CO4	2	-	-	-	-	-	-	-	1	2	-	-
CO5	2	-	-	-	3	-	-	-	1	2	-	-

1:Slight(Low) 2: Moderate(Medium) 3: Substantial(High) If there is no correlation put“-”.

## Course Content

### Unit –I

Lettering and Dimensioning: Introduction, lettering practices, Rules of dimensioning – systems of dimensioning. Geometric Constructions: Freehand sketching, Conic Sections, Special Curves. Engineering Scales

### Unit –II

Orthographic Projection, Projection of Points: First and Third Angle Projections; Projection of Points, Projection of Lines: Projection of straight lines (First angle projection only); Projection of lines inclined to one plane and both planes, true length and true inclinations. Projection of solids: Classification of solids, Projection of solids in simple position, Projection of solids inclined to one plane.

### Unit –III

Sections of Solids: Right regular solids and auxiliary views for the true shape of the sections. Development of Surfaces: Development of surfaces for various regular solids.

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## Unit –IV

Isometric Projection: Isometric scales, Isometric projections of simple and combination of solids;  
Perspective Projection: Orthographic representation of perspective views – Plane figures and simple solids – Visual Ray Method. Conversion of pictorial view into orthographic Projection.

## Unit –V

Introduction to Auto CAD, Drawings of Buildings and their components – front view, top view, and sectional views of a typical residential building using Auto CAD.  
Detailed Drawing of RCC Design- Slab, beam, column, footings.

### Textbooks

1. D.A. Jolhe (2008). 'Engineering Drawing- With an Introduction to AutoCAD.', Tata McGraw, Delhi.
2. N D Bhatt and V M Panchal (2001). 'Engineering Drawing.', 43rd Ed., Charotar Publishing House, Anand, 2001.
3. M B Shah and B C Rana (2009). 'Engineering Drawing.', 2nd Ed., Pearson Education, Delhi.

### Reference Books

1. A Textbook of Engineering Graphics by K.V. Natarajan.
2. T E French, C J Vierck and R J Foster, *Graphic Science and Design*, 4th Ed., McGraw Hill, 1984.
3. W J Luzadder and J M Duff, *Fundamentals of Engineering Drawing*, 11th Ed., PHI, 1995.
4. K Venugopal, *Engineering Drawing and Graphics*, 3rd Ed., New Age International, 1998

### Web Resources

1. <https://nptel.ac.in/courses/112103019>
2. <https://nptel.ac.in/courses/112102304>
3. <https://nptel.ac.in/courses/112105294>
4. <https://archive.nptel.ac.in/courses/112/102/112102304/>

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## Year I, Semester II ENGINEERING CHEMISTRY

NCY-101 / 102

L-T-P-C: 3-0-2-4

### OBJECTIVE:

The objective of this course is to make students learn the laboratory skills needed to design safe conduction of reactions and experiments in Chemistry. The student will acquire a foundation of Chemistry to enable them to understand and critically interpret the primary research in Chemistry.

### Course outcome

On the successful completion of the course, students will be able to

CO1	Interpret UV-Visible and IR-Spectra	K2, K4
CO2	Describe reaction rates for reactions of various orders	K2, K3, K4
CO3	Understand different aspects of corrosion and thermodynamic view of electrochemical processes, reversible, irreversible cells and nano chemistry	K2, K3
CO4	Understand the stereochemistry of molecules and identify organic reactions on the basis of their mechanism	K1, K3, K4
CO5	Distinguish between different polymeric structures, classify polymers, and analyze the polymerization mechanism and use of polymers in different walks of life. Knowledge of conductivity of polymer, biodegradable polymers and fibre reinforced plastics. Acquire knowledge about water and treatment of municipal water and solid waste management	K2, K3, K5, K6
CO6	To develop experimental skills to perform, monitor and manipulate the reactions.	K2, K4, K5

K1-Remember, K2-Understand, K3-Apply, K4-Analyse, K5- Evaluate, K6-Create

### Course Articulation Matrix (CO-PO Matrix)

PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
3	3	1	3	2	-	2	-	-	-	-	3
3	3	1	3	2	-	2	-	-	-	-	3
3	3	1	3	2	-	2	-	-	-	-	3
3	3	1	3	2	-	2	-	-	-	-	3
3	3	1	3	2	-	2	-	-	-	-	3
3	3	3	3	2	2	2	2	1	2	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) if there is no correlation put“-”.

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## Course Content

### UNIT- 1

**Bonding** VSEPR Theory, Valence Bond Theory, Crystal-field theory, Electronic Spectra and Ligands (strong and weak field), Phosphorescence and Fluorescence, Jablonski diagram, hydrogen bonding and their effect on physical properties, Metallic bonds, Classification and Applications of Liquid crystals, Band Theory of Solids and superconductors.

**Spectroscopy:** Basic Principles, Instrumentation and Applications of UV-Vis and IR Spectroscopy.

### UNIT- 2

**Chemical Kinetics:** Second order reactions, Determination of order, Fast and slow reaction, steady state approximation, Temperature effect, Concept of Activated Complex / Transition State: Energy of activation, Potential energy surface, Theories of reaction rate: Collision and Transition State theories in terms of enzyme catalysis.

**Surface Chemistry:** Introduction, Types of adsorption, Adsorption isotherms, BET, Applications of adsorption.

### UNIT- 3

**Electrochemistry:** Dry and fuel cells, electro chemical cell, Solar cells, Disensitized cell, Photovoltaic cell.

**Nanochemistry:** Introduction, general methods of synthesis, classification and applications of nano materials.

**Environmental Chemistry:** Air and Water Pollution, analysis of gaseous effluents, oxides of Nitrogen, oxides of Sulphur and  $H_2S$ , chemical analysis of effluents liquid streams, BOD, COD, control of pollution, Depletion of ozone layer.

### UNIT- 4

**Stereochemistry:** Stereoisomerism of organic compounds containing one & two chiral centers. Enantiomers & Diastereomers, E-Z nomenclature, R-S configuration, Atropisomerism, and Optical isomerism in Allenes, biphenyl and Spiranes, Circular Dichroism.

**Reaction Mechanism:** Inductive, Electromeric and Mesomeric effects, Study of reaction intermediates (Carbanion, carbocation, carbene, nitrene and benzyne). Mechanism of nucleophilic and electrophilic substitution reactions. Mechanism and application of following reactions:

- Suzuki-Miyaura Cross coupling reaction
- Fries and Photo-Fries Rearrangement
- Wagner-Meerwein Rearrangement
- Umpolung Reactions
- Favorskii Rearrangement

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## UNIT- 5

**Polymers:** Introduction, types of polymers, Molecular mass-number and mass average molecular weight, determination of molecular mass by Osmometry, viscosity, light scattering and size exclusion chromatography, Rheological properties and uses of some common polymers. Synthetic Polymers(carbon framework, silicon framework, fluorinated polymer), Conducting and Biodegradable polymers.

**Water Analysis:** Introduction; Hardness of Water- cause, types, units, Disadvantages of using hard water for domestic and industrial purposes, Softening of hard water, Chemical analysis of Water-estimation of free chlorine, total alkalinity, hardness, Numerical based on determination of hardness.

**Solid Waste Management:** Classification, waste treatment & Disposal methods (Composting, sanitary land filling, thermal processes, recycling and reuse).

### List of Experiments:

1. Determination of alkalinity in given water sample.
  - i. Sodium Carbonate & Sodium Bicarbonate
  - ii. Sodium Carbonate & Sodium Hydroxide
2. Determination of temporary and permanent hardness in water sample using EDTA as standard solution.
3. Determination of Chloride content of water by Mohr's Method.
4. Determination of Chlorine content in Bleaching powder.
5. Determination of strength of supplied Ferrous Ammonium Sulphate (FAS) solution in using external, internal indicators.
6. Determination of viscosity of a given liquid by Ostwald's viscometer.
7. Determination of surface tension of a given liquid by Stalagmometer.
8. Determination of end point in acid base titration using pH metric method.
9. Determination of Dissociation constant of weak acids by conductometric Titration.
10. To prepare aspirin (acetyl salicylic acid) from salicylic acid.
11. Synthesis of polyurethane.
12. Find the concentration of the given samples using visible spectroscopy.

### Textbooks

Engineering Chemistry by Shashi Chawla, Publisher: Dhanpat Rai & Co.

### Reference Books:

1. Organic Chemistry by I. L. Finer, Vol-1, Ninth Edition, 2015, Pearson Publisher.
2. Physical Chemistry by Puri, Sharma & Pathania, Vishal Publishing Co., 48th Edition, 2021, ISBN: 978-93-87015-81-4
3. Polymer Science by V.R. Gowarikar, N.V. Vishwanathan and J. Shridhar, Wiley Eastern Ltd., New Delhi, 1987, ISBN: 978-0470203224.
4. Elementary Organic Spectroscopy by Y.R. Sharma, S. Chand, Fifth Edition, 2013, ISBN:



9788121928847.

**Web links**

1. <https://nptel.ac.in/courses/104101121> [Prof. Debabrata Maiti, IIT Bombay]
2. <https://nptel.ac.in/courses/104106119> [Prof. Harinath Chakrapani & Prof. Neeraja Dashaputre, IIT Madras]
3. <https://nptel.ac.in/courses/104105084> [Prof. Debashis Ray, IIT Kharagpur]
4. <https://nptel.ac.in/courses/104106129> [Prof. M. V. Sangaranarayanan, IIT Madras]

**Evaluation Scheme:**

S. No.	Course Type	Subject Code	Course title	Credits (L-T-P)	Sessional Marks				ES M	Total Marks
					MSE	TA	Lab	Total		
1	BSC	NCY 101/102	Engineering Chemistry	4(3-0-2)	15	20	15	50	50	100

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## INTRODUCTION TO COMPUTER SCIENCE AND ENGINEERING

NCS-101/102

L-T-P-C: 3-1-0-4

### Course Objective:

To explain the fundamentals of the computer system in terms of hardware components and basics of an operating system, understanding of programming, database management systems, and working with Internet and web applications.

### Course Outcomes (COs):

At the end of this course students should be able to:

CO1	Understand hardware components of computer systems such as memory system organization, and input/output devices, and be aware of software components of computer system	Understand	K1
CO2	Understand Operating systems and be able to develop basic shell scripts.	Understand, Apply	K1,K2
CO3	Develop a basic understanding of programming and get a concept of algorithmic thinking.	Apply, Analyze	K2,K3
CO4	Understand Databases, Use SQL to write queries.	Understand, Evaluate	K1,K4
CO5	Explain how the Internet works and be able to make basic static Web applications.	Understand, Create	K1,K5

K1-Understand, K2-Apply, K3-Analyse, K4-Evaluate, K5-Create

### Course Articulation Matrix (CO-PO Matrix)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	2	1	1	-	-	-	-	-	-	-	-	-
CO3	3	3	2	3	1	-	-	1	1	1	1	1
CO4	3	2	2	3	1	-	-	-	1	-	2	1
CO5	3	2	3	1	2	1	1	2	2	2	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) if there is no correlation put "-".

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## Course Content

### Unit - 1

**Fundamentals of Computers:** Introduction to Computers - Computer Definition, Characteristics of Computers, Evolution, and History of Computers, Types of Computers, Basic Organization of a Digital Computer; Classification of Digital Computer Systems: Microcomputers, Minicomputers, Mainframes, Supercomputers. Number Systems, Computer Codes – BCD, Gray Code, ASCII, and Unicode; Boolean Algebra – Boolean Operators with Truth Tables; Types of Software – System Software and Utility Software; Computer Languages - Machine Level, Assembly Level & High-Level Languages, Translator Programs – Assembler, Interpreter and Compiler; Planning a Computer Program – Data Structures, Algorithm, Flowchart and Pseudo code with Examples.

### Unit-2

**Operating System Fundamentals:** Operating Systems, Introduction, Functions of an Operating System, Classification of Operating Systems, System programs, Application programs, Utilities, The Unix Operating System, Basic Unix commands, Microkernel Based Operating System, Booting.

### Unit-3

**Fundamentals of C Programming Language:** Introduction to C Programming Languages, Structure of C programs, compilation and execution of C programs, Debugging Techniques, Data Types and Sizes, Declaration of variables, Modifiers, Identifiers and keywords, Symbolic constants, Storage classes (automatic, external, register and static), Enumerations, comma and line parameters, Macros, The C Preprocessor.

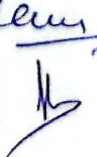
Operators: Unary operators, Arithmetic & logical operators, Bitwise operators, Assignment operators and expressions, Conditional expressions, Precedence, and order of evaluation.

Control statements: if-else, switch, break, and continue the comma operator, go to statement. Loops: for, while, do-while. Functions: built-in and user-defined, function declaration, definition and function call, and parameter passing: call by value, call by reference, recursive functions. Arrays: linear arrays, multidimensional arrays, passing arrays to functions, Arrays, and strings.

### Unit-4

**Introduction to Database Management Systems:** Database, DBMS, Why Database -File system vs DBMS, Database applications, Database users, Introduction to SQL, Data types, Classification of SQL-DDL with constraints, DML, DCL, TCL

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## Unit-5

**Internet Basics:** Introduction, Features of the Internet, Internet application, Services of the Internet, Logical and physical addresses, Internet Service Providers, Domain Name System.

**Web Basics:** Introduction to web, web browsers, http/https, URL, HTML5, CSS

### Text Books:

1. Kernighan B.W., Ritchie D.M., "The C Programming Language", 2<sup>nd</sup> Edition, Prentice Hall Software, 2015
2. V. Rajaraman, "Fundamentals of Computers", 6<sup>th</sup> Edition, PHI Learning Pvt. Ltd., 2015
3. Peter Norton's, "Introduction to Computers", 7<sup>th</sup> Edition, Tata McGraw Hill, 2017
4. David Riley and Kenny Hunt, "Computational Thinking for Modern Solver", Chapman & Hall/CRC, 1<sup>st</sup> Edition, 2014

### Reference:

1. J. Glenn Brook shear, "Computer Science: An Overview", Addison-Wesley, Twelfth Edition, 2017
2. R.G. Dromey, "How to Solve it by Computer", PHI, 1982
3. Balagurusamy E., "Fundamentals of Computers", Second ed. 2009, McGraw Hill
4. Thareja R., "Fundamentals of Computers", 2014, Oxford University Press.

### Web link:

1. [https://onlinecourses.swayam2.ac.in/cec19\\_cs06/preview](https://onlinecourses.swayam2.ac.in/cec19_cs06/preview)

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# INTRODUCTION TO ELECTRONICS ENGINEERING

**NET-101/102**

**L-T-P-C: 3-1-0-4**

**Course Objective**

To understand the fundamentals of analog & digital electronic devices like diode, transistor, logic gates, flip-flop and to understand the working principles of common Instruments used in electronic measurement.

**Course Outcomes (CO):**

At the end of this course students should be able to:

CO1	To understand the basic concept of diodes, and use the diode as a circuit element for different applications.	K2,K3
CO2	To understand the working of BJT, FET and OP-amp and their application.	K2, K3, K6
CO3	To design the simple digital circuits using different logic gates.	K4, K6
CO4	To identify the errors while making electronic measurements and to understand the working of different types of transducers.	K1, K4, K5
CO5	To understand the working principle of electronic instruments and displaying it on electronic devices.	K1, K2, K4

K1- Remember, K2- Understand, K3-Apply, K4-Analyse, K5- Evaluate, K6- Create

**Course Articulation Matrix (CO-PO Matrix)**

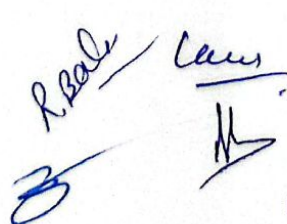
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	1	-	-	-	-	-	-	-
CO2	2	3	3	3	2	2	-	-	-	-	-	-
CO3	3	2	1	3	2	1	-	-	-	-	-	-
CO4	3	2	1	1	1	-	-	-	-	-	-	-
CO5	3	1	3	2	1	-	-	-	-	-	-	-

1: Slight(Low) 2: Moderate(Medium) 3: Substantial(High) If there is no correlation put“-”.

**Course Content**

**Unit-I:**

P-N Junction Diode, Depletion layer, Barrier potential, forward and reverse bias, Knee voltage, V-I Characteristics and its Equivalent Models, Avalanche and Zener Break Down, Diode Applications as Half Wave, Full Wave & Bridge Rectifier and their comparative analysis, Clippers, Clampers, Voltage Multiplier Circuit, Zener Diode and its Applications as a voltage regulator, Varactor diode.

  
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**Unit-II:**

Basic theory and operation of PNP and NPN transistors, Characteristics of Common Base, Common Emitter and Common Collector configuration, DC Biasing : Fixed Bias, Emitter Bias, voltage divider bias, Field effect transistor: JFET, Drain and Transfer characteristic, MOSFET, Introduction to Operational Amplifier and its Applications as Adder, Subtractor, Integrator, Differentiator, log antilog.

**Unit-III:**

Number System, Base Conversion, BCD code, Excess-3 code, Gray Code, Review of Logic Gates, Concept of Universal Gates &, Boolean laws and theorems, SOP and POS representation of Boolean functions, Minimization of Boolean functions using K map, Basic Combinational Circuits: Half Adder, Full Adder, Subtractor, Sequential Circuits: Latch, Flip-Flops, Characteristic and Excitation Table of SR, JK, D and T Flip-flop. Concept of Master Slave Flip-Flop, Shift Registers.

**Unit-IV:**

Functional Elements of Instruments, Classification & Characteristics, Types of Errors, Sources of Error, Dynamic Characteristics, Active and Passive Transducers: Resistive Transducers, Thermistor, Strain Gauge, Thermocouple, Differential Output Transducers, LVDT and their Characteristics.

**Unit-V:**

Display Devices: LCD, LED, Seven Segment Display, Alphanumeric Display, Electronic Ammeter and Voltmeter, Digital Multi-meter, Cathode Ray Oscilloscope (CRO), Digital Storage Oscilloscope (DSO)

**Text Books:**

1. Electronics Principles by Albert Malvino, & David Bates, 2016, Tata McGraw-Hill, Eighth Edition, ISBN-978-0-07-337388-1
2. Electronic Devices & Circuit Theory by Boylestad, Robert & Nashelsky, 2015, Louis, Prentice Hall of India, Eleventh Edition, ISBN- 10-9332542600
3. Electronic Instrumentation and Measurements by H.S. Kalsi, 2019, Tata McGraw-Hill, Fourth Edition, ISBN-10-9353162513
4. Digital Principles and Applications by Leach, Malvino, & Saha, 2014, Tata McGraw-Hill, 8th Edition, ISBN-10- 9789339203405

**Reference Books:**

1. Microelectronic Circuits by Adel Sedra, Kenneth C.(KC) Smith, Tony Chan Carusone, Vincent Gaudet, 2020, Oxford University Press, 8th Edition, ISBN-10-0190853468
2. A Course in Electrical and Electronic Measurements and Instrumentation by A K Sawhney 2021, Dhanpat Rai & sons, ISBN-10-8177001000
3. Fundamentals of Microelectronics by Behzad Razavi, Wiley, Second Edition, ISBN-13:9781118156322

**Web Links:**

1. <https://nptel.ac.in/courses/108101091>
2. <https://nptel.ac.in/courses/122106025>

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## Introduction to Data Science and Analytics

**Course Code: NMA-112**

**L-T-P-C: 3-0-2-4**

**OBJECTIVE:** To equip students with:

- Introductory background of data science and data management
- Introductory background of data analytics and some popular algorithms/tools
- Emerging trends in data science and data analytics

### Course Outcomes:

	On satisfying the requirements of the course and upon its successful completion, students will have knowledge/skills/competency to:	
<b>CO 1</b>	have exposure to data repositories, data science jobs, & data science tools	K1, K2
<b>CO 2</b>	have exposure to data management tools, techniques, technologies and best practices	K1, K2
<b>CO 3</b>	have exposure to data analytics, EDA and few machine learning models	K2
<b>CO 4</b>	apply various tools for a variety of data visualizations	K2, K3
<b>CO 5</b>	get acquainted with/to emerging trends in data science and data analytics	K2

### Course Articulation Matrix (CO-PO Matrix)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	3	-	-	1	1	2	-	3
CO2	3	3	2	1	2	-	-	1	1	1	-	3
CO3	3	3	1	1	3	-	-	1	2	3	-	3
CO4	3	3	2	1	2	-	-	1	3	1	-	3
CO5	3	3	1	1	3	-	-	1	1	2	-	3
Average	3	3	2	1	2	-	-	1	1	3	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) if there is no correlation, put“-“

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## SYLLABUS

**UNIT-I: Introduction to Data Science:** Definition and terminology, Data Repository and Methods, Data Science Personnel with roles and skills required, Types of Data, Data Science Process, Data Science Projects Lifecycle, Popular Data Science Toolkits and Example Applications.

**UNIT-II: Data Management:** Introduction, benefits, Types, Data Management Lifecycle, Data Collection and Management, Exploring Data, Building Models, Storage Management, Data Management tools and techniques, Cloud Data Management Technologies Data Management Best Practices.

Data Management using Python/R/Java script/Tableau/ Power BI.

**UNIT-III: Introduction to Data Analytics:** Introduction, Data Analytics and various approaches/variants. Summary Statistics: Measures of Frequency, Measures of Central Tendency, Measures of Dispersion, Measures of Location, Measures of Shape of Distribution, Measures of Relationship

Introduction to Machine Learning: Types, Linear Regression, Classification, Dimensionality Reduction, Clustering, Support Vector Machine, Naïve Bayes.

Data Analysis using Python/R/ Java script/Tableau/Power BI.

**UNIT-IV: Data Visualization:** Introduction, Examples, Importance, Workflow and Principles, Categories and Types, Selection of Type of Data Visualization and Best Practices, Role, Tools/Software/Techniques in Data Science, Benefits of the Tools,

Data Visualization using Python/R/Java Script/Tableau/ Power BI.

**UNIT-V: Recent Trends in Data Science:**

Intelligent Digital Mesh, Artificial Intelligence, Intelligent Apps and Analytics, Intelligent Things, Digital Twins, Edge Computing, Intelligent Platforms, Immersive Experience, Block Chain, Event Driven Techs, CARTA, Importance of Big Data Visualization, Key Issues and Popular Tools; Visualizing Big Data; SAS Visual Analytics, Word Clouds, Network Diagrams and Correlation Matrices, Pre Attentive Attributes, Challenges and Potential Solutions, Future Progress.

**Lab Work:** Development and execution of at least 15 programs from relevant units.

### Text Books:

1. V.K. Jain, Data Science and Analytics, Khanna Book Publishing Co, (P) LTD.
2. Sandhya Arora and Latesh Malik, Data Science and Analytics with Python, Universities Press, 2023.

Any other textbook recommended by the instructor.

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## Python for Data Science

**Course Code: NMA-114**

**L-T-P-C: 3-0-2-4**

**OBJECTIVE:** To equip students with:

- Fundamental concepts of Python programming language
- Skills of Python programming
- Data science skills using Python libraries/packages

### Course Outcomes:

	On Satisfying the requirements of the course and upon its successful completion, students will have knowledge/skills/ competency to:	
CO 1	State, explain and use Python data types, operators, control structures and function to develop Python programs.	K2, K3
CO 2	State, explain and use data structures, array functions and modules in Python for Python coding/developing Python scripts	K2, K3
CO 3	Use Python OOPs concepts in programming, regular expression for defining filters and apply open source My SQL and Postgre SQL for Python applications/data storage	K3
CO 4	To apply some popular open source Python libraries for array manipulation, data manipulation, data visualization, statistical computing and modeling	K3, K4
CO 5	To apply some popular open source Python libraries to build machine learning and deep learning models, SQL data basis handling and natural language processing	K3, K4

### Course Articulation Matrix (CO-PO Matrix)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	-	-	1	1	2	-	3
CO2	3	3	2	1	2	-	-	1	2	2	-	3
CO3	3	3	2	1	2	-	-	1	1	2	-	3
CO4	3	3	2	1	2	-	-	1	2	2	-	3
CO5	3	3	2	1	2	-	-	1	2	2	-	3
Average	3	3	2	1	2	-	-	1	2	2	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) if there is no correlation, put“-“

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## SYLLABUS

**UNIT-I: Fundamentals of Python Programming-1:** Introduction, Features, and uses, Data Types, Variables Assignments, I/O Operations, Operators, Expressions, Strings, Conditional Statements, Loops, Loop Control Statements, Functions: Built-in, Recursion, Lambda and user-defined functions.

**UNIT-II: Fundamentals of Python Programming-2:** Data Structures: Lists, Tuples, Sets, Dictionaries with related operations; Array functions: filter( ),map ( ),reduce ( ) and zip ( ) functions for iterable manipulations; Modules: Importance and importing modules, commonly used In-Built modules, creating and importing user-defined modules.

**UNIT-III Fundamentals of Python Language-3:** OOPs Concepts: Classes, Objects Methods, Inheritance, Constructors, Polymorphism, Abstraction, and Sets, Encapsulation, Exception, Handling, Working with Files, Regular Expressions and SQL, Database Access, Databases MySQL and Postgre SQL.

**UNIT-IV: Python Libraries for Data Science-1:** Introduction, Installation/Access/Importing, Features and Applications of IPython, Jupyter, Google Colab, NumPy, SciPy, Pandas, Matplotlib, Seaborn, , SymPy, Statsmodels etc.

**UNIT-V: Python Libraries for Data Science-2:** Introduction, Installation/Access/Importing, Features and Applications, Scikit-Learn, TensorFlow, Keras, PyTorch, SQLAlchemy, nltk, Gensim etc.

**LAB WORK:** Development and execution of any 3-4 programs from each unit I, II & III, using programming concepts and implementation of any 3-4 Python libraries from each of units IV and V.

### Text Books:

1. Michael Urban and Joel Murach, Python Programming, Shroff /Murach 2016.
2. Cotton, R., Learning R: a step-by-step function guide to Data Analysis First edition, O' Reilly Media Inc.

### Reference Books:

1. Mark Lutz, Programming Python, O'Reilly, 4<sup>th</sup> Edition, 2010.
2. Gardener, M., Beginning R: The Statistical Programming Language, Wiley, 2017.

Any other textbook recommended by the instructor.

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## WORKSHOP PRACTICE

**NWS 101 / 102**

**L-T-P-C: 0-0-4-2**

**Course Objective:** The objective of this course is to educate and impart basic knowledge of various hand tools and equipments and their use in different shops, day to day industrial work and domestic life. Students able to understand safety precautions in the workshop. Student acquires skills of application oriented task.

**Course Outcome**

At the end of the course the student should be able to :

CO 1	Study and practice on machine tools and their operations	K2
CO 2	Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry, black-smithy and welding work	K3
CO 3	Identify and apply suitable tools for machining processes including plain turning, step turning, taper turning, facing, thread cutting operations	K4
CO 4	Understand and practice welding and forging operations	K3
CO 5	Select the appropriate tools required for specific operation and the proper safety measure required to be taken while using different tools.	K2, K3

K1 - Remember, K2- Understand, K3 - Apply, K4 -Analyze, K5 - Evaluate, K6 – Create

**Course Articulation Matrix (CO-PO Matrix)**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	1	1	1	-	-	-	-	-	1
CO2	2	-	-	1	1	1	-	-	-	-	-	1
CO3	2	-	-	1	1	1	-	-	-	-	-	1
CO4	2	-	-	1	1	1	-	-	-	-	-	1
CO5	2	-	-	1	1	1	-	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) if there is no correlation put“-”.

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## C01

1. Working principle of lathe machine
2. Parts and operations on lathe machine
3. Tool geometry of single point cutting tool

## C02

1. Study and practice of different tools used in Fitting shop, Carpentry shop and Foundry shop.
2. Study and practice of different tools used in Black-smithy shop, Sheet metal shop and Welding shop.

## C03

1. Explanation and demonstration of various processes like plain turning and step turning.
2. Explanation and demonstration of various processes like taper turning and facing.
3. Explanation and demonstration of various processes like thread cutting, knurling and chamfering.

## C04

1. Classification of different welding processes with the help of flow chart.
2. Explanation and demonstration forging operations.
3. Safety precautions during actual forging and welding.

## C05

1. Selection of proper drilling tool for drilling operation.
2. Selection of proper tap for internal thread cutting operation.
3. Selection of power hacksaw blade, wood cutting cutter, snips, chisels etc.

## C06

1. Proper demonstration of safety precautions to be taken for example leather apron, leather hand gloves, welding shield etc.
2. Description of different safety tools and precautions in workshop.

## Course Content

### 1. Carpentry Shop

Practice (I) : To prepare half lap corner joint from given pieces of mango wood.

Practice (II) : To prepare mortise and tenon joint from given pieces of mango wood.

Instructions : Description and demonstration of different tools, joints along with advanced carpentry joints, classification and definition of timber, wood seasoning, demonstration of wood working lathe and advanced power tools used in carpentry work, safety precaution during actual working.

### 2. Fitting and Bench working Shop

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- Practice ( I ) : To prepare male-female joint from given pieces of mild steel.  
 Practice ( II ) : To prepare practice work piece involving marking, measuring, sawing, drilling and tapping operations.  
 Instructions : Classification and description of different tools used in fitting shop e.g. marking and measuring tools , holding and supporting tools, striking tools and cutting tools etc. , safety precaution during actual working.

### 3. Black Smithy Shop

- Practice ( I ) : To prepare 'L' shape job from given piece of mild steel rod by hand forging.  
 Practice ( II ) : To prepare a 'Ring' from given piece of mild steel rod by hand forging.  
 Instructions : Description of various forging processes done in black-smithy work e.g. upsetting, drawing down, punching, bending, fullering etc, classification and description of different tools, Equipments used in black smithy shop, safety precaution during actual working.

### 4. Welding Shop

- Practice ( I ) : To prepare simple butt joint and lap joint by electric arc welding from given pieces of mild steel.  
 Practice ( II ) : To prepare simple lap joint by oxy-acetylene gas welding and gas flame Cutting practice.  
 Instructions : Concept of welding, classification and explanation of various types of welding with the help of flow chart, description of different tools. Equipments required for arc welding and gas welding, demonstration of various types of flames in Oxy-acetylene gas welding, setting of current and selection of electrodes along with different welding joints, safety precaution during actual working.

### 5. Sheet Metal Shop

- Practice ( I ) : To prepare a funnel complete with soldering from given G.I. sheet.  
 Practice ( II ) : To fabricate tray / tool box or electric panel box from given G.I. sheet.  
 Instructions : Classification and description of different types of tools, Equipments used in sheet metal work, different types of metals used in sheet metal shop e.g. Galvanized iron, lack iron, copper, aluminum etc., concept of development of surfaces along with different types of joints in sheet metal work, safety precaution during actual working.

### 6. Machine Shop

- Practice ( I ) : To prepare a job by plain turning, facing, step turning and chamfering Operation from given mild steel rod.  
 Practice ( II ) : To prepare a job by taper turning, threading, knurling operations from given mild steel rod.  
 Instructions : Classification of lathe machines, different parts of lathe machine, tools and Equipments used, explanation and demonstration of various operations on



lathe machine, tool geometry of single point cutting tool, cutting speed, feed and depth of cut in turning, safety precaution during actual working.

## 7. Foundry Shop

- Practice ( I ) : To prepare a mould of given pattern in Green Sand  
 Practice ( II ) : To prepare a mould with two step pulley with runner and riser  
 Instructions : Description and use of various foundry tools, showel, flat rammer, hand rammer, strike off bars, vent wire, trowels, hand riddle etc. Types of various moulding sands, types of patterns, pattern materials, pattern allowances, safety precautions during actual working.

### Text Books

1. Elements Of Workshop Technology Vol-1, by Choudhury H S K, MPP Pvt. Ltd., 2008
2. A Course in Workshop Technology Vol I by Raghuwanshi, Dhanpat Rai & sons, 2011.
3. Workshop Practice Manual by V Kapoor, Dhanpat Rai & sons, 1998
4. Workshop Technology: Manufacturing Processes by Khurmi & Gupta, S. Chand Publications, 2008

### Reference books

- 1-Mechanical Workshop Practice, 2/E 2nd edition, Kindle Edition, K.C.John, PHI, 2010.
- 2-Workshop Practice , Singh Swarn, Katson Books, 2003.
- 3- Workshop Practice, R.K.Rajput, 2016.
- 4- Workshop Practice, B.L.Juneja, Cengage Learning Publishers, 2015.

### Link:

- 1- <https://sjce.ac.in/wp-content/uploads/2018/04/Workshop-Laboratory-Manual.pdf>
- 2- <https://nptel.ac.in/courses/112107219>

### Evaluation Scheme

Course Title	Credit (L:T:P)	Sessional Marks				ESM	Total Marks
		MSE	T A	Lab	Total		
Workshop Practice	2(0-0-4)	--	20	30	50	50	100

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## Year II, Semester III

### ENGINEERING MATHEMATICS-II

NMA-201

L-T-P-C: 3-1-0-4

**OBJECTIVE: The objective of this course is to educate the students about:**

- Ordinary differential equations and their applications as mathematical models.
- Series solutions of ordinary differential equations and special functions.
- Laplace transform, Fourier series, differential equations and boundary value problems.

#### Course Outcome

On the successful completion of the course, students will be able to

CO1	Solve first and higher order ordinary differential equations.	Apply, Analyze Evaluate,
CO2	Find series solutions of ordinary differential equations and learn Bessel's and Legendre's function and its applications.	Apply, Analyze Evaluate,
CO3	Solve IVPs and BVPs using Laplace Transform.	Apply, Analyze Evaluate,
CO4	Find Fourier series expansion of given function and solve partial differential equations.	Apply, Analyze Evaluate,
CO5	Solve boundary value problems using variable separable method etc.	Apply, Analyze Evaluate,

#### Course Articulation Matrix (CO-PO Matrix)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	-	-	1	-	1	-	3
CO2	3	3	2	1	2	-	-	1	-	1	-	3
CO3	3	3	2	1	2	-	-	1	-	1	-	3
CO4	3	3	2	1	2	-	-	1	-	1	-	3
CO5	3	3	2	1	2	-	-	1	-	1	-	3
Average	3	3	2	1	2	-	-	1	-	1	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) if there is no correlation, put "-"

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## Detailed Syllabus

### Unit-I: Ordinary Differential Equations:

First order ordinary differential equations, Existence and uniqueness of solutions of initial value problems, Solution of higher order linear differential equation with constant coefficients, Solution of second order differential equations by changing dependent and independent variables, Cauchy-Euler equations, Methods of diagonalization, undetermined coefficients and variation of parameters: Nonlinear equations, Linear and nonlinear models, Initial value and boundary value problems, Systems of equations. Application of differential equations as mathematical models, Models from population dynamics, Newton's Law of cooling, electric circuit, Oscillation of spring.

### Unit-II: Series Solutions of Ordinary Differential Equations & Special Functions:

Ordinary and singular points of an equation, Power series solutions, Frobenius method, Bessel's and Legendre's equations and their series solutions, Properties of Legendre's polynomials and Bessel's functions, Generating functions, Fourier-Bessel series and Fourier-Legendre series expansions, Sturm-Liouville Problem and related theorems.

### Unit-III: Laplace Transform:

Laplace transform, Existence conditions and ROC, Inverse Laplace transform, Operational properties, Convolution, Unit step function, Dirac-Delta function, Periodic functions, Applications to solve IVPs and BVPs: Linear ordinary differential equations, Transfer function and control system analysis.

### Unit-IV: Fourier Series and Partial Differential Equations:

Orthogonal functions, Fourier series, existence conditions, Fourier series of even and odd functions, convergence of Fourier series, Fourier half range series, Harmonic analysis, Complex Fourier series and frequency spectrum. Development of partial differential equations and Solutions, Solution of first order partial differential equations, Solutions of linear higher order partial differential equations with constant coefficients.

### Unit-V: Boundary-Value Problems:

Classification of second order partial differential equations, Derivation of heat and wave equations, solutions in rectangular coordinates by separation variable method, solution of Laplace equation, D'Alemberts solution of wave equation, Non-homogeneous equations and boundary conditions, Orthogonal series expansions, Fourier series in two dimensions, Boundary value problems in polar, cylindrical and spherical coordinate systems and their solutions.

### Books Recommended:

1. E.A.Coddington, An Introduction to Ordinary Differential Equations, Practice Hall, 1995.
2. I.N.Sneddon, Elements of Partial Differential equations, McGraw-Hill 1957.
3. Dennis G.Zill & Michael R.Cullen; Advanced Engineering Mathematics, Jones & Bartlett Publishers. 2<sup>nd</sup> Edition.
4. R.K.Jain & S.R.K. Iyengar; Advanced Engineering Mathematics, Narosa Publishing House, 2002.
5. Erwin Kreyszig; Advanced Engineering Mathematics, John Wiley & Sons 8<sup>th</sup> Edition.

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## Data Structures and Algorithms

Course Code: NMA-211

L-T-P-C: 3-0-2-4

**OBJECTIVE:** The objective of this course is to educate the students about:

- Data management and performance analysis of algorithms
- Implementation of linear and non-linear data structures in designing algorithms
- Sorting and searching algorithms, hashing and file structures and their applications

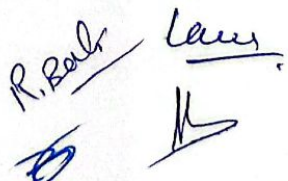
### Course Outcomes:

	On satisfying the requirements of the course and upon its successful completion, students will have knowledge/skills/competency to:	
CO 1	explain data management best practices and available platforms and data structures with their uses; analyze performance of algorithms	K2, K4
CO 2	use various linear data structures to gain suitable experience about their implementation	K3
CO 3	choose right non-linear data structure for designing algorithms and coding	K3, K4
CO 4	use various sorting and searching algorithms to gain suitable knowledge about their implementation	K2, K3
CO 5	apply hashing to store and retrieve data in data structures, decide the implementation of file structures in data structures	K3, K5

### Course Articulation Matrix (CO-PO Matrix)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	-	-	1	2	2	-	2
CO2	3	3	2	1	2	-	-	1	2	2	-	3
CO3	3	3	2	1	2	-	-	1	2	2	-	2
CO4	3	3	2	1	2	-	-	1	2	2	-	3
CO5	3	3	2	1	2	-	-	1	2	2	-	2
Average	3	3	2	1	2	-	-	1	2	2	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) if there is no correlation, put“-“

  
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# SYLLABUS

## UNIT-I: Fundamentals:

**Introduction to Data Structures:** Data Management Concepts and Types, Importance, Data Management Practices and Platforms, Data Types – Primitive and non- Primitive, Data Structures and Classification.

**Algorithm Specifications:** Performance, Analysis and Measurement (Time and Space Analysis of Algorithms-Average, Best and Worst-case Analysis) using Asymptotic Analysis and Master Theorem. Types of Algorithms with brief Introduction and Applications.

## UNIT-II: Linear Data Structures:

**Arrays:** Representation, Types, Operations, Applications, Sparse Matrix: Benefits, Representations & Implementation.

**Stacks:** Introduction, Operations, Applications; Polish Expression, Reverse Polish Expression and their Compilation, Recursion, Tower of Hanoi.

**Queues:** Representation, Types, Operations, Applications and Implementation.

**Linked Lists:** Definition, Types, Operations, Application, Linked-list Implementation of Sparse matrix, Stack and Queue.

## UNIT-III: Nonlinear Data Structures:

**Trees:** Introduction, Properties, Applications, Advantages and Disadvantages, Operations on the following with time Complexity: Binary Trees and Types, Threaded Binary Trees, Heap Trees, Binary Search Trees, AVL Trees, B- Trees, B+ Trees, Red-Black-Trees, 2-3 Trees.

**Graphs:** Introduction, Terminology, Types, Representation: Adjacency Matrix, Adjacency List, Elementary Operations: BFS, DFS, Connected Component, Spanning Trees, Minimal Spanning Trees: Kruskal's Algo. and Prim's Algo., Shortest Paths: Dijkstra's Algo., Bellman Ford's Algo., Floyd Warshall's Algo.

**UNIT-IV: Sorting and Searching Algorithms:** Introduction, Implementation and Time Complexity, Space Complexity of: Insertion, Quick, Merge, Heap, Bubble, Selection, Counting, Redix, Bucket, Shell Sort. Sorting On Several Keys, List and Table Sort, Linear Search, Binary Search.

**UNIT-V: Hashing and File Structures:** Hashing: the Symbol Table, Hashing Functions, Collision -Resolution Techniques.

**File Structure:** Concepts of Fields, Records and files. Sequential, Indexed and Relative / Random File Organization, Indexing Structure for Index files, Hashing for Direct Flies, Multi-Key File Organization and Access Methods.

**LAB WORK:** Development and execution of any 3-4 programs from each unit. using Python.

## Text Books

1. Michael T. Goodrich, Roberta Tamassia, Michael H. Goodwasser; "Data Structures and Algorithms in Python" Wiley India Pvt. Ltd. An Indian Adaptation.
2. Subrata Saha "Data Structures and Algorithms Using Python" Cambridge University Press



### Reference books

1. John Canning, Alan Broder, Rabext Lafore "Data Structures & Algorithms in Python" Addison-Wesley Professional
2. Kent D. Lee, Steve Hubbard; "Data Structures and Algorithms with Python" Springer.
3. Hemant Jain; "Problem Solving in Data Structures & Algorithms using Python" Third Edition.
4. Shriram K Vasudevan, Abhishek S Nagarajain, Karthick Nanmaran, "Data Structures Unsing Python" Oxford, Higher Education.
5. Michael T. Goodrich, Tamassia, Michael H. Goldwasser "Data Stuctures and Algorithms in Python", Wiley.

Any other textbook recommended by the instructor.

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# SYLLABUS

**UNIT-I: Sampling Distributions:** Statistical Inference, Population Parameter, Sample Statistic. Sampling Distributions of Sample mean, Proportion, Difference and Sums, Variance, Ratio of Variances etc, Frequent Distribution, Sample Mean, Variance and Moments for Group Data, Exact Sampling Distributions; Chi-square, Students-t, F-Distributions, Sampling Theory for Regression and Correlation, Sample Covariance Matrix.

**UNIT-II: Parameter Estimation:** Estimates and its Properties, Point Estimation: Maximum Likelihood Estimates of Parameters in various pmfs and pdfs; Interval Estimation, Confidence Intervals for Mean, Proportion, Difference and Sum, Variance, Ratio of Variances.

### UNIT-III: Hypothesis Tests and Significance:

Statistical Hypotheses, One tailed and Two-tailed Tests, Type I and Type II Errors, Level of Significance, P Value, Special Tests of Significance for Large Samples: Tests for Mean, Proportion, Differences of Means and Differences of Proportions, Special Tests of Significance for Small Samples: Tests for Means, Differences of Means, Variances, Ratios of Variances, Fitting Theoretical Distributions to Sample Frequency Distributions, Goodness of Fit Tests.

**UNIT-IV: Non-Parametric Tests:** Introduction, Sign Test, Mann-Whitney U Test, Kruskal-Wallis H Test, Runs Test for Randomness, Further Applications of Runs Test, Spearman's Rank Correlation.

**UNIT-V: Bayesian Methods:** Prior and Posterior Distributions, Likelihood, Sampling from a Binomial, Poisson and Normal populations, Improper and Conjugate Prior Distributions, Bayesian Point and Interval Estimation, Bayesian Hypothesis Tests, Bayes Factors, Bayesian Predictive Distributions.

**LAB WORK:** Development and execution of any 3-4 programs from each unit using Python/SPSS/R.

### Text Book:

1. Murray R Spiegel, John J Schiller and R Alu Srinivasan, Adapted By Debasree Goswami, "Probability and Statistics" Third Edition, Schaum's Outlines, McGraw Hill Education India Pvt Ltd

### Reference Books:

1. Jianqing for Runzeli, Cun-Hui Zhang Hui Zou "Statistical Founalations of Data Science" CRC Press.
2. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani "An Introduction to Statistical Learning with Applications in R", Second ed. 2021 Edition Springer.

Any other textbook recommended by the instructor.

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# Probability and Random Processes

Course Code: ENMA-215

Unit: 1 (3:00:00)

**OBJECTIVE:** The objective of this course is to educate the students about

- Probabilistic modeling, random variables and standard theoretical distributions
- Random processes and their classification
- Discrete and continuous parameter Markov chains and their applications

## Course Outcomes:

On satisfying the requirements of the course and upon successful completion, students will have knowledge/skills/competency to:

CO	Description	POs
CO-1	explain basis concepts of probability and probabilistic modeling, apply Bayes rule, evaluate moments of random variables	K1, K3
CO-2	have exposure to some common discrete theoretical distributions, distributions of functions of discrete random variables and multiple random variables	K2
CO-3	have exposure to some common continuous theoretical distributions, distributions of functions of continuous random variables and multiple random variables	K1, K2
CO-4	have familiarity with random processes, stationarity, ergodicity, some special processes, evaluate correlation function and spectral density	K1, K2
CO-5	analyze discrete and continuous parameter Markov chains for stochastic modeling of random processes	K1, K2

## Course Articulation Matrix (CO-PO Matrix)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2							3
CO2	3	3	1	1	2							3
CO3	3	3	2	1	2							3
CO4	3	3	2	1	2							3
CO5	3	3	2	1	2							3
Average	3	3	2	1	2							3

1=Sign (Low), 2=Moderate (Medium), 3=High


  
 Date: 29/09/2024  
 Prof. Ram Aitak  
 Head, Dept. of Mathematics  
 JSSR, Navegaon, Bangalore-56002



## SYLLABUS

**UNIT-I: Basic Principles of Probability:** Probabilistic Modeling, Sample Space, Events, Concept and Axioms of Probability, Conditional Probability, Independent Events, Total Probability Theorem, Bayes' Rule and Inference, Independence, Conditioning, Random Variables, Probability Distributions, Expectation, Moments, Transforms.

**UNIT-II: Discrete Random Variables:** Basic Concepts, PMF & CMF, Expectation & Summary Measures, Transforms, Common Discrete Random Variables, Functions of Random Variables, Multiple Random Variables, Joint & Marginal PMFs, Functions of Multiple Random Variables, Conditioning, Independence, Random Sums, Bivariate and Multivariate Binomial Process.

**UNIT-III: Continuous Random Variables:** Basic Concepts, PDF & CDF, Expectation & Summary Measures, Transforms, Important Continuous Random Variables, Functions of Random Variables, Multiple Random Variables, Joint & Marginal PMFs, Functions of Multiple Random Variables, Conditioning, Independence, Random Sums, Bivariate and Multivariate Gaussian Process.

**UNIT-IV: Random Processes:** Stochastic Processes and Types, Classification, SSS Process, Markov Process, Autocorrelation, Cross-Correlation, Spectral Density, WSS Process, Ergodicity, Beroulli Process, Poisson Process, Merging and Splitting.

**UNIT-V: Markov Chains:**

**Discrete Parameter Markov Chains:** Basic Concepts, Computation of n-Step Transitional Probabilities, State Classification and Limiting Distributions,

**Continuous Parameter Markov Chains:** Basic Concepts, Chapman-Kolmogorov Equations, State Classification, Birth and Death Processes and Various Types of Queuing Models/ Processes.

**LAB WORK:** Development and execution of any 3-4 programs from each unit using Python.

**Text Books:**

1. KS Trivedi, Probability and Statistic with Reliability, Queuing and Computer Science Applications, Prentice Hall of India, Pvt Lid.

**Reference Books:**

2. S. Palaniammal, "Probability and Random Processes" Eastern Economy Edition, PHI Learning, Pvt. Lit.
3. A Papoulis and Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes" McGraw Hill.
4. Scott L. Miller, Donald G. Childers, "Probability and Random Processes" Academic Press.

Any other textbook recommended by the instructor.



## Real Analysis

**Course Code: NMA-217**

**L-T-P-C: 3-0-0-3**

**OBJECTIVE:** The objective of this course is to educate the students about:

- Real number systems, convergence of real number sequences
- Continuity and differentiability of real-valued functions
- Evaluation of Riemann integrals

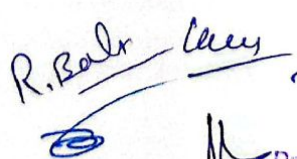

### Course Outcomes:

	On satisfying the requirements of the course and upon its successful completion, students will have knowledge/skills/competency to:	
CO 1	Analyze real number systems	K4
CO 2	Examine the convergence of real number sequences	K4
CO 3	Investigate continuity of real-valued functions	K4
CO 4	Investigate differentiability of real-valued functions	K2, K4
CO 5	Evaluate Riemann integrals	K5

### Course Articulation Matrix (CO-PO Matrix)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	-	-	1	-	1	-	3
CO2	3	3	2	1	1	-	-	1	-	1	-	3
CO3	3	3	2	1	1	-	-	1	-	1	-	3
CO4	3	3	2	1	1	-	-	1	-	1	-	3
CO5	3	3	2	1	1	-	-	1	-	1	-	3
Average	3	3	2	1	1	-	-	1	-	1	-	3

1: Slight(Low) 2: Moderate(Medium) 3: Substantial(High) if there is no correlation, put“-“

  
  
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## SYLLABUS

**UNIT-I:** Review of Algebraic and Order Properties of  $R$ ,  $\epsilon$ -neighborhood of a point in  $R$ , Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima, The completeness Property of  $R$ , The Archimedean Property, Density of Rational (and Irrational) numbers in  $R$ , Intervals, Interior point, Open Sets, Closed sets, Limit points of a set, Illustrations of Bolzano-Weierstrass theorem for sets, closure, interior and boundary of a set.

**UNIT-II:** Sequences and Subsequence, Bounded sequence, Convergent sequence, Limit of a sequence, Limit Theorems, Monotone Sequences, Divergence Criteria, Bolzano Weierstrass Theorem for Sequences, Cauchy sequence, Cauchy's Convergence Criterion, Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's  $n$ th root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

**UNIT-III:** Limits of functions (epsilon-delta approach), sequential criterion for limits, divergence criteria, Limit theorems, one-sided limits, Infinite limits and limits at infinity, Continuous functions, sequential criterion for continuity & discontinuity, Algebra of continuous functions, Continuous functions on an interval, Boundedness Theorem, Maximum Minimum Theorem, Bolzano's Intermediate value theorem, location of roots theorem, preservation of Intervals theorem, Uniform continuity, non-uniform continuity criteria, uniform continuity theorem, Monotone and Inverse Functions.

**UNIT-IV:** Differentiability of a function at a point & in an interval, Caratheodory's theorem, chain Rule, algebra of differentiable functions, Mean value theorem, interior extremum theorem, Rolle's theorem, intermediate value property of derivatives, Darboux's theorem, Applications of mean value theorem to inequalities.

**UNIT-V:** Riemann integral, Riemann integral functions, Darboux theorem(statement only), Necessary and sufficient condition for Riemann integrability, Properties of integrable functions, Fundamental theorem of integral calculus, First Mean-Value theorem.

### Text Books

1. R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis (Third Edition), John Wiley and Sons (Asia) Pvt. Ltd, Singapore, 2002
2. G.Das and S. Pattanayak, Fundamental of Mathematical Analysis, TMH, Publishing Co.

### Reference Books

1. S.C. Malik and Savita Arora-Mathematical Analysis, New Age International Publications
2. A.Kumar, S. Kumareson, A Basic course in Real Analysis, CRC Press, 2014.
3. Brian S. Thomson, Andrew. M. Bruckner, and Judith B. Bruckner, Elementary Real Analysis, Prentice Hall, 2001.
4. Gerald G. Bilodeau, Paul R. Thie, G.E. Keough, An Introduction to Analysis, Jones and Bartlett, Second Edition, 2010.

Any other textbook recommended by the instructor.

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## ECONOMICS AND MANAGEMENT

NHS 201/202

L-T-P-C: 3-0-0-3

Course: B. Tech.	Branch: All branches	Semester: 3rd & 4th
Sessional Marks:	50	Credit: 3
End Semester Exam:	50	LTP: 3 0 0

### UNIT I: Introduction to Economics:

Overview: production possibility curve, choices-what, how and for whom, micro- and macroeconomics, inflation, unemployment, GDP and business cycle; demand and supply, elasticity of demand, consumer surplus and its applications.

### UNIT II: Production, Cost and Market:

Production function, Cost Function, Types of Market: Perfect Competition, Monopoly, Oligopoly

### UNIT III: Fundamentals of Management:

Development of Management Thoughts; Objectives, Functions of Management

### UNIT IV: Functional Areas of Management-I

Human Resource Management: HRP, Recruitment and Selection, Performance Appraisal; Marketing Management: Functions, Strategies

### UNIT V: Functional Areas of Management-II

Finance Management: Objectives, Functions; Operations Management: Concepts, Functions, Inventory Management

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### Text Books:

1. Koutsoyiannis, A., "Modern Microeconomics", English Language Book Society, Macmillan.
2. Joseph, L Massod, "Essential of Management", Prentice Hall, India.
3. S. P. Robbins, "Management", Prentice Hall, India

### Additional Reference Books:

1. Armstrong, Michel, "A Handbook of Management Techniques", Kogan Page Limited
2. Samuelson, Paula, "Economics", 5<sup>th</sup> edition, McGraw Hill New York.
3. Henderson, J Mand Quadnt, RE, "Microeconomic Theory: A Mathematical Approach.
4. "Tata MacGraw Hill, New Delhi, 2003

### Course Outcome (COs)

1. Understand essential economic principles for solving economic problems with suitable policy alternatives.
2. Apply the knowledge of production, cost and market functions
3. Understand and apply basic functions of management

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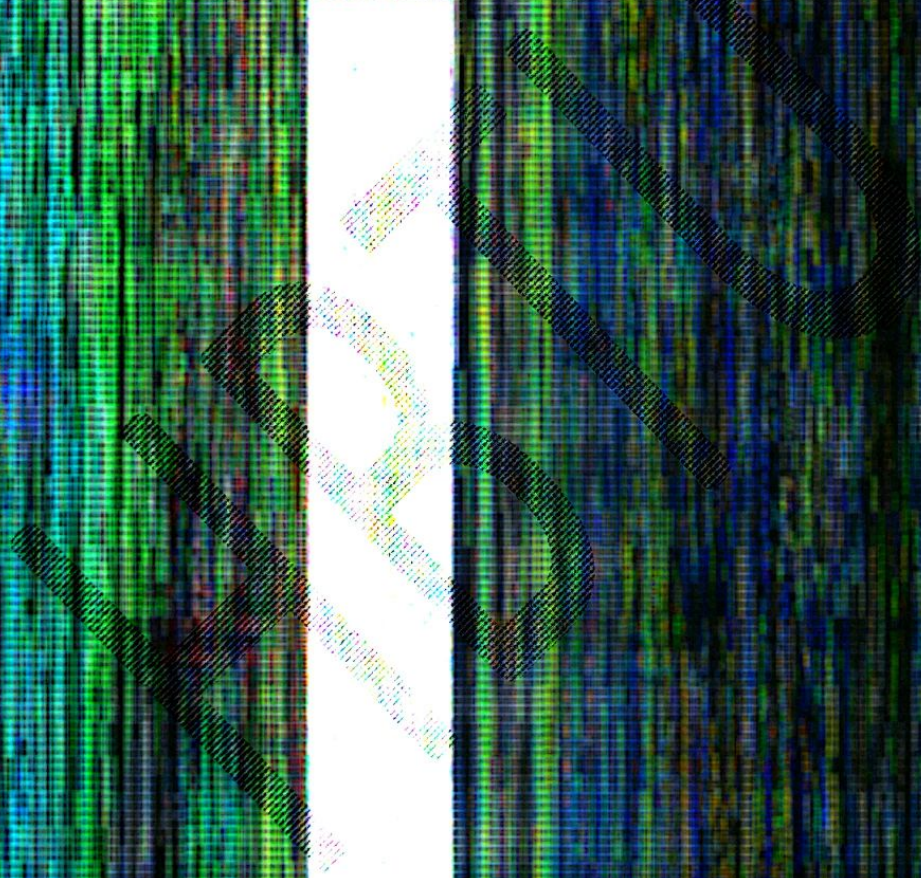
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- 4. Develop and apply the understanding of people and marketing.
- 5. Develop and apply the understanding of finance and operations.

**CO-PO Mapping**

Co/PO	PO 1	PO 2	PO3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	0	0	0	0	0	0	2	1	0	0	0	2
CO2	0	0	0	0	0	0	2	1	0	0	0	2
CO3	0	0	0	0	0	0	2	1	2	2	1	2
CO4	0	0	0	0	0	0	2	1	2	2	2	2
CO5	0	0	0	0	0	0	2	1	2	2	3	2



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## Data Science Lab-1

**Course Code:** NMA-219

**L-T-P-C:** 0-0-4-2

**OBJECTIVES:** The objectives of this course are to educate the students about

- Exploratory data analysis
- Use of regression / classification algorithms
- Use dimensionality reduction / clustering algorithms

**Course Outcome:** On the successful completion of the course, students will be able to

CO1	visualize data.	K3, K5
CO2	compute summary measures	K2, K6
CO3	examine significance of summary measures	K1, K5
CO4	implement regression / classification algorithms	K4, K5
CO5	implement dimensionality reduction / clustering algorithms	K2, K3

**CO-PO Mapping:**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	-	-	1	2	3	1	2
CO2	3	3	3	3	3	-	-	1	2	3	1	2
CO3	3	3	2	3	3	-	-	1	2	3	1	2
CO4	3	3	3	3	3	-	-	-	2	3	1	2
CO5	3	3	2	3	3	-	-	2	2	3	1	2
Average	3	3	3	3	3	-	-	1	2	3	1	2

1: Slight (Low), 2: Moderate (Medium) 3: Substantial (High) if there is no correlation, put“-“

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## Data Science Lab-1

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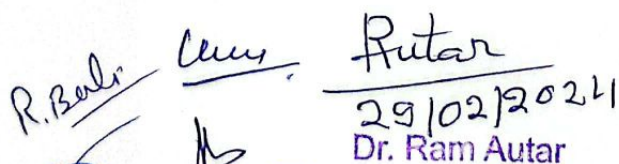
**Course Outcome:** On the successful completion of the course, students will be able to

CO1	visualize data.	K3, K5
CO2	compute summary measures	K2, K6
CO3	examine significance of summary measures	K1, K5
CO4	implement regression / classification algorithms	K4, K5
CO5	implement dimensionality reduction / clustering algorithms	K2, K3

### CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	-	-	1	2	3	1	2
CO2	3	3	3	3	3	-	-	1	2	3	1	2
CO3	3	3	2	3	3	-	-	1	2	3	1	2
CO4	3	3	3	3	3	-	-	-	2	3	1	2
CO5	3	3	2	3	3	-	-	2	2	3	1	2
Average	3	3	3	3	3	-	-	1	2	3	1	2

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## Syllabus:

- Data visualization using matplotlib
- Data visualization using seaborn
- Data visualization using Bokeh
- Computation of summary measures and testing of their significance
- Implementation of simple linear/multiple linear/polynomial regression using sklearn libraries
- Implementation of Bernoulli/Multinomial/Gaussian Naïve Bayes classifier using sklearn libraries
- Implementation of SVM with linear/polynomial/RBF kernel for classification using sklearn libraries
- Implementation of PCA for dimensionality reduction of data using sklearn libraries
- Implementation of K-Means for clustering of data using sklearn libraries

**LAB WORK:** 20-30 Python codes of real life problems are to be developed and executed.

### References:

1. Bharti Motuwani, "Data Analytics using Python", Wiley
2. Jesus Rogel – Salazar, "Data Science and Analytics with Python" CRC Press, Taylor & Francis Group.

Any other textbook recommended by the instructor

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# Year II Semester IV

## ENGINEERING MATHEMATICS-III

(Semester-IV: II-B.Tech, Engineering Stream)

Course Code: NMA-202

L-T-P-C: 3-1-0-4

**OBJECTIVE: The objective of this course is to provide conceptual understanding of:**

- various mathematical tools like Laplace/ Fourier transforms and their applications.
- concepts and principle of complex analysis in solving various real-life problems.
- various statistical methods and tests for analyzing experimental data.

**Course Outcome:** On the successful completion of the course, students will be able to

CO1	solve boundary value problems using Laplace transform and Fourier transform methods and solve difference equations and BVPs using z transform.	K3, K5
CO2	construct conformal mapping between many kinds of domains.	K2, K6
CO3	evaluate complex integrals, improper real integrals using various formulae/theorems and find Taylor and Laurent's series expansion of complex functions.	K1, K5
CO4	estimate relationship between two variable using curve fitting, regression and its strength using correlation.	K4, K5
CO5	various parametric and nonparametric tests parameter estimation, hypothesis testing and ANOVA.	K2, K3

### CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	1	2	1	1	-	1	3
CO2	3	3	3	3	2	1	2	1	1	-	1	3
CO3	3	3	3	3	2	1	2	1	1	-	1	3
CO4	3	3	3	3	1	1	-	-	-	-	-	2
CO5	3	3	3	3	1	2	3	2	2	1	1	2
Average	3	3	3	3	1.6	1.2	1.8	1	1	.5	.8	2.6

1: Slight (Low), 2: Moderate (Medium) 3: Substantial (High) if there is no correlation, put“-“

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## Detailed Syllabus:

### Unit – I: Transform Methods:

10 hours

Fourier integral, conditions of convergence, Fourier sine and cosine integrals, complex form, Fourier transform pairs, existence conditions, operational properties, applications of Laplace transform, and Fourier transform to solve boundary value problems, Discrete and Fast Fourier transforms and its applications. Development of difference equations as models, Methods of solution: operator method, method of undetermined coefficients, Z-transform pairs, ROC, operational properties, limiting-value theorems, its applications to solve difference equations and BVP, systems of difference equations.

### Unit- II: Functions of a Complex Variable and Conformal mapping:

8 hours

Limit, continuity, differentiability and analyticity, Cauchy-Riemann equations, harmonic functions, complex functions as mappings, linear transformation, inverse transformation, bilinear transformations, conformal mapping, applications.

### Unit- III: Integration of Complex Functions:

8 hours

Contour integrals and evaluations, Cauchy- integral theorem, Cauchy's integral formulae, Liouville's theorem, convergence of power series, Taylor series, Laurent series, zeros and singularities of a complex function, residues and residue theorem, fundamental theorem of algebra, Rouché's theorem, Argument Principle and maximum modulus theorem, evaluation of definite and improper integrals.

### Unit- IV: Curve- Fitting, Correlation, Regression and Probability:

8 hours

Curve-fitting, method of least- squares: fitting of straight lines, polynomials, non-linear and exponential curves etc., correlation analysis, linear, non-linear, and multi-regression analysis, probability, random variables and probability distributions, expectation, moments and transform methods, Binomial, Poisson, and Normal distributions.

### Unit- V: Statistical Methods:

6 hours

Sampling theory (small and large), parameter estimation, confidence intervals, tests of hypotheses and significance; Overview of t-distribution, F-distribution and  $\chi^2$ -distribution, Z-, t-, F-, and Chi-square tests, goodness of fit test:  $\chi^2$  test, analysis of variance, non-parametric tests (simple application), time series analysis, index numbers, quality control charts.

### Text Books:

1. Dennis G, Zill & Michael R. Cullen; Advanced Engineering Mathematics, Jones & Bartlett Publishers. 2 nd Edition.
2. R.K. Jain & S.R.K. Iyengar; Advanced Engineering Mathematics, Narosa Publishing House, 2002.
- 3 Erwin Kreyszig; Advanced Engineering Mathematics, John Wiley & Sons 8th Edition.

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4. R.V. Churchill and J.L. Brown, Complex Variables and Applications, McGraw Hill, 1990.

**Reference Books:**

1. J.N. Kapur and H.C. Saxena, Mathematical Statistics, S.Chand. & Co., 2001.

2. H.C. Saxena, Practical Mathematical Statistics, S. Chand & Co., 2000.

3. J.H. Mathews and R.W. Howell, Complex Analysis for Mathematics and Engineering, 3 rd Ed. Narosa, 1998.

4. H. K Das and Er. Rajnish Verma; Higher Engineering Mathematics, S. Chand publishing, 1st edition, 2011.

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## COMPUTER ORIENTED NUMERICAL METHODS

**Course Code: NMA-204.**

**L-T-P-C: 3-0-2-4**

**OBJECTIVE:** The objective of this course is to provide conceptual understanding of:

- Various numerical methods for solving linear and nonlinear equations.
- Various numerical techniques of interpolation, integration, and differentiation with their applications.
- Various numerical methods to solve IVPs and BVPs .



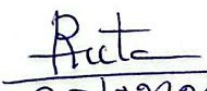
**Course Outcome:** On the successful completion of the course, students will be able to

CO1	find roots of nonlinear equations and solve systems of algebraic equations.	K1, K5
CO2	use interpolation techniques and to find numerical differentiation/integration of data, function.	K3, K5
CO3	use numerical methods for finding solutions of ordinary differential equations, simultaneous and higher order equations.	K3, K5
CO4	learn numerical methods for finding solution of initial and boundary value problems, partial differential equations.	K1, K2
CO5	learn basic concepts of some Finite element methods.	K1, K2

### CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	1	1	1	-	-	-	-	3
CO2	3	2	3	3	1	1	1	-	-	-	-	3
CO3	3	2	3	3	1	1	1	-	-	-	-	2
CO4	3	2	3	3	1	1	1	-	-	-	-	3
CO5	3	2	3	3	1	1	1	-	-	-	-	3
Average	3	2	3	3	1	1	1	-	-	-	-	3

1:Slight(Low) 2:Moderate(Medium)3:Substantial(High) If there is no correlation, put“-“



  
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## Detailed Syllabus:

**UNIT I: Nonlinear Equations and Simultaneous Linear Equations: 12 hours**  
Roots of nonlinear equation: Methods of solution, Order of convergence of iterative methods, Simple roots: Bisection, False position, Secant, Newton-Raphson, Chebyshev, Iteration and multi point iteration methods, Multiple roots: Newton-Raphson and Chebyshev, Complex roots: Newton-Raphson and Muller's method, System of nonlinear equations: Newton-Raphson and Iteration methods, Polynomial equations: Bairstow's method, convergence analysis of above methods.

**Linear systems of Equations:** Introduction, Direct methods, Operation count, Pivoting, Ill conditioned linear systems &, condition number, Iteration methods: Jacobi, Gauss-Seidel, SOR methods, convergence conditions. Special systems of equations: Thomas algorithm, Eigen value problems: Given's and Power methods.

**UNIT II: Interpolation, Differentiation and Integration: 10 hours**  
Curve fitting: Polynomial interpolation, error, existence and uniqueness, truncation error bounds, difference operators, Newton forward and backward difference interpolations, Lagrange, Newton divided difference and iterated interpolations, Stirling and Bessel's interpolations, Spline interpolation, Least squares and Chebyshev approximations, Numerical differentiation: Methods based on interpolation, error analysis, Numerical integration: methods based on interpolations (Trapezoidal, Simpson's 1/3, Simpson's 3/8 rule), Gauss quadrature methods, Romberg integration, error bounds and estimates.

**UNIT III: Numerical Solution of Ordinary Differential Equations: 6 hours**  
Initial-value problems, Single step methods: Taylor's, Picard's, Euler's, Modified Euler's method and Runge-Kutta method (fourth order), error estimates, multi-step methods, Adam's-Bashforth and Milne's methods, convergence and stability analysis, Simultaneous and Higher order equations: RK Fourth order method.

**UNIT IV: Initial & Boundary Value Problems and Iterative Solvers: 6 hours**  
BVP: Shooting method and finite difference methods for ordinary differential equations, Solution of partial differential equations: Laplace, Poisson equations: standard 5- point and diagonal 5- point formulae, Jacobimethod, Gauss Seidel method (Liebmann's iterative method), Relaxation method. Solution of heat equation: Crank – Nicolson method, Solution of wave equation.

**UNIT V: Finite Element Method: 6 hours**  
Basic concepts, variational formulation and functional, base functions, approximations weighted residual methods: Ritz method, Galerkin method, least squares method, collocation method, Finite element and solution of simple problems and time dependent

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problems.

#### NT Lab:

Develop Programs of the following techniques in C/C++ Language:

1. To implement iterative methods to solve a nonlinear equation.
2. To implement iterative methods to solve a system of linear equations.
3. To implement Forward, Backward and Central difference interpolation formulae.
4. To implement Newton's divided difference and Lagrange's interpolation formulae.
5. To implement Numerical differentiation.
6. To implement Numerical integration using Trapezoidal, Simpson 1/3 and Simpson 3/8 rules.
7. To implement single step methods to solve initial value problems.
8. To implement multi step methods to solve initial value problems.
9. Solution of Heat equations (Parabolic equations) by finite difference method.
10. Solution of Laplace equations (elliptic equations) by finite difference method.
11. Solution of wave equations (Hyperbolic equations) by finite difference method.

#### Books Recommended:

1. M.K. Jain, S.R.K. Iyengar & R.K. Jain, Numerical methods for Scientific and Engineering Computation, New Age International Publication.
2. S.S. Sastry, Introductory Methods of Numerical Analysis, Eastern Economy Edition.
3. S. Rajsekar, Numerical Method in Science and Engineering, Wheeler Publishing House.
4. B.S. Grewal, Numerical Method in Engineering & Science, Khanna Publisher.

#### Reference Books:

1. Chapra, S.C. and Canale, R.P., "Numerical Methods for Engineers", Tata McGraw – Hill.
2. Balagurusamy, E., "Numerical Methods", Tata McGraw – Hill.
3. Bradie, Brian (2006). A Friendly Introduction to Numerical Analysis. Pearson Education India. Dorling Kindersley (India) Pvt. Ltd. Third Impression, 2011.
4. K. W. Morton and D. F. Mayers, Numerical Solution of Partial Differential Equations, Cambridge University Press.

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## NUMERICAL OPTIMIZATION

Course Code: NMA- 212

L-T-P-C: 3-0-2-4

**OBJECTIVE:** The objective of this course is to educate the students about:

- First order and second – order gradient based optimization methods.
- First order iterative algorithms for optimization problems in deep learning.
- LPP and some classical algorithms to solve constrained optimization problems and convex optimization problems.

Course Outcomes:

	On satisfying the requirements of the course and upon its successful completion, students will have knowledge and skills to:	
CO 1	formulate univariate and multivariate optimization models for real – life situations and apply first order gradient based methods to solve unconstrained optimization problems.	<b>K3, K6</b>
CO 2	Explain the mostly-studied first order iterative algorithms for optimization problems in deep learning.	<b>K2</b>
CO 3	discuss the theory of some second – order gradient based optimization methods and apply to solve unconstrained optimization problems.	<b>K2, K3</b>
CO 4	cast real – life problems into linear programming problems and apply select methods to solve the LPP.	<b>K3, K6</b>
CO 5	select and apply some classical algorithms to solve constrained optimization problems and convex optimization problems.	<b>K3</b>

CO-PO Mapping:

CO	PO1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	3	-	3	-	1	1	-	-	-	2
CO2	3	2	3	-	3	-	1	1	-	-	-	2
CO3	3	2	3	-	3	-	1	1	-	-	-	2
CO4	3	2	3	-	3	-	1	1	-	-	-	2
CO5	3	2	3	-	3	-	1	1	-	-	-	2
Average	3	2	3	-	3	-	1	1	-	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) if there is no correlation, put“-“

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## Detailed Syllabus

**Unit-I:** Background, One Dimensional and multi dimensional Optimization with types, Gradient Based Optimization Methods (I): method of steepest descent, conjugate gradient method, the generalized reduced gradient method, gradient projection method.

**Unit-II:** Stochastic gradient method (SGD), SGD with momentum, NAG, Adagrad, RMS Prop, Adadelta, Adam, Nadm, Adamx,

**Unit-III:** Gradient based Optimization Methods (II): Newton type methods (Newton's method, Levenberg- Marquardt's method), The quasi-Newton method.

**Unit-IV:** Linear Programming: Convex analysis, Simplex method. Two phase simplex method, Duality theory, Dual simplex method.

**Unit-V:** Constrained Optimization Methods: Lagrange's multiplier, The Kuhn-Tucker conditions, Convex optimization, Penalty function techniques, The Method of multiplier, Linearly constrained problems-Cutting plane method, Primal dual method.

**LAB WORK:** Implementation of any 2-3 techniques from each unit (selected by the instructor) using MATLAB.

### Text Books:

1. M.C. Joshi, K.M. Moudgalya, Optimization: Theory and Practice, Narosa Publishing House, 2004.
2. J.A. Snyman, Practical Mathematical Optimization, Springer Sciences, 2005.
3. Nocedal J, Wright S.J., Numerical Optimization, Springer
4. Stephen Boyd, Lieven Vandenberghe, Convex Optimization, Cambridge University Press.

Any other text recommended by the instructor.

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## COMPUTATIONAL LINEAR ALGEBRA

**Course Code:** NMA- 214

**L-T-P-C:** 3-0-2-4

**OBJECTIVE:** The objective of this course is to educate the students about:

- Basic algorithms of matrix multiplication and SVD.
- Techniques to solve unsymmetric eigen value and symmetric eigen value problems.
- Matrix orthogonalization and factorization.


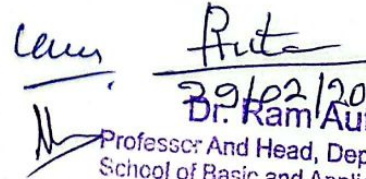
### Course Outcomes:

	On satisfying the requirements of the course and upon its successful completion, students will have knowledge and skills to:	
CO 1	explain the vector space structure with related concepts and use basic algorithms of matrix multiplication.	<b>K2, K3</b>
CO 2	discuss basic linear algebraic concepts, norms, principle underlying SVD etc and solve triangular systems of linear equations using LU factorization / parallel LU, Gaussian elimination and pivoting strategies,	<b>K2</b>
CO 3	apply various methods to solve special linear systems of equations and perform matrix orthogonalization and factorization as well as solve the full – rank and rank – deficient least squares problems,	<b>K3</b>
CO 4	solve modified least squares problems and unsymmetric eigen value problems by select methods / algorithms,	<b>K5</b>
CO 5	utilize select algorithms to solve the symmetric eigen value problems and to compute SVD and evaluate matrix functions,	<b>K3</b>

### CO-PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	3	1	2	1	1	-	-	-	-	3
CO2	3	2	3	1	2	1	1	-	-	-	-	3
CO3	3	2	3	1	2	1	1	-	-	-	-	2
CO4	3	2	3	1	2	1	1	-	-	-	-	3
CO5	3	2	3	1	2	1	1	-	-	-	-	3
Average	3	2	3	1	2	1	1	-	-	-	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) if there is no correlation, put“- “

  
  
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## Syllabus

**Unit-I: Vector Space and Matrix Multiplication:** Overview of Vector space, Basic algorithm and notations, Structure and efficiency, Block matrices and algorithms, Fast matrix - vector products, Vector products, Vectorization and locality, Parallel matrix multiplication.

**Unit-II Matrix Analysis:** Basic ideas from linear algebra, Vector norms, Matrix norms, The singular value decomposition, Subspace matrices, The sensitivity of square systems, Finite precision matrix computation.

**General Linear Systems:** Triangular systems, The LU factorization, Round off error in Gaussian elimination, Pivoting, Improving and Estimating Accuracy, Parallel LU.

**Unit-III Special Linear Systems:** Diagonal Dominance and symmetry, Positive definite systems, Banded systems, Symmetric indefinite systems, Block tri-diagonal systems, Vandermonde systems, classical methods for Toeplitz systems, Circulant and discrete Poisson systems.

**Orthogonalization and Least Square:** Householder and Givens transformations, The QR factorization, The full - rank least square problem, Other orthogonal factorizations, The rank deficient least square problem, square and undetermined systems.

**Unit-IV Modified Least Square problems and Methods:** Weighting and regularization, Constrained least squares, Total least squares, Subspace computations with SVD, Updating matrix factorizations, Un-symmetric Eigen Value Problems: properties and Decomposition, Perturbation theory, Power iterations, The Heisenberg and real Schur Forms, The practical QR algorithm, Invariant subspace computations, The generalized Eigen value problem, Hamiltonian and product Eigen value problems, Pseudo spectra.

**Unit-V Symmetric Eigen Value Problems:** Properties and decompositions, Power iterations, the symmetric QR algorithm, more methods for tri-diagonal problems, Jacobi methods, Computing the SVD, Generalized Eigen value problem with symmetry.

**Functions of Matrices:** Eigen value methods, approximation methods, The matrix exponential, the sign, Square root and Log of a matrix.

**LAB WORK:** Implementation of any 2-3 techniques from each unit (selected by the instructor) using MATLAB.

### Text Book:

1. Gene. H. Golub, Charles F. Van Loan, Matrix Computations, Fourth Edition, The Johns Hopkins University Press, Baltimore 2013.

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**Reference Books:**

1. J. W. Demmel, Applied Numerical Linear Algebra, SIAM, 1997.
2. P.G. Ciarlet, Introduction to numerical linear algebra and optimization
3. William Ford, Numerical linear algebra with applications, AP
4. Richard Bronsom, G.B. Costa, Matrix Methods: Applied Linear Algebra, Third Edition, AP.

Any other text recommended by the instructor.

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# DISCRETE MATHEMATICAL STRUCTURES

Course Code: NMA-216

L-T-P-C: 3-0-0-3

**OBJECTIVE: The objective of this course is**

- to develop the logical ability by providing exposure to mathematical logic, proof methods, set theory, relation, and functions etc.
- to provide knowledge about coding theory fundamentals, algebraic structures, posets, lattices, Boolean algebra for applications in computer science.
- to provide exposure of combinatorics and graph theory for applications in computer science

**Course Outcome:** On the successful completion of the course, students will be able to

CO1	understand concept of logic and various inference mechanisms using logic.	K2
CO2	understand set theory, function, relation, and the concepts of theorem proving.	K2, K3
CO3	explain algebraic structures and coding theory.	K4
CO4	understand and apply concepts of posets, lattices and Boolean algebra in computer science.	K2, K3
CO5	understand and apply graph theory and concepts of recurrence relations and generating functions in system modeling.	K2, K3

**CO-PO Mapping:**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	3	1	2	-	3	3
CO2	3	3	3	3	3	2	3	1	2	-	3	3
CO3	3	3	3	3	3	2	3	1	3	-	3	3
CO4	3	3	3	3	3	2	3	1	3	-	3	3
CO5	3	3	3	3	3	2	3	-	3	-	3	3
Average	3	3	3	3	3	2	3	.8	2.6	-	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put “-“

## Detailed Syllabus:

**UNIT I: Fundamentals of Logic:**

**8 hours**

**Propositional Logic:** Propositions, basic logic operations and truth tables, tautologies, contradictions, contingency, algebra of propositions, logical equivalence: the laws of logic.

**Logical implication:** Rules of inference, logical analysis of argument, some computing application (normal forms), functionally complete set of operations.

**First Order Logic:** Predicates & quantifiers, nested quantifiers, use of quantifiers,

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rules of inference, validity of arguments, proof methods.

**UNIT II: Set Theory, Relations and Functions:**

**8 hours**

**Set Theory:** Sets & subsets, Venn diagrams, set operations and laws, countable set, Cartesian product, cardinality, principle of inclusion-exclusion.

**Relations:** Relation, representation & properties, n-ary relations and applications, composition of relations, closures of relations, equivalence relation & partitions, partial orders, compatibility relation.

**Functions:** Functions and its types, inverse function, composition of functions, special functions, recursively defined functions, computational complexity, analysis of algorithms.

**Theorem Proving Techniques:** Mathematical induction (weak, strong, structural) and its applications, proof by contradiction, Pigeonhole principle.

**UNIT III: Algebraic Structures and Coding Theory:**

**8 hours**

**Algebraic Structures:** Definition, properties, semi group, monoid, group, properties of groups, subgroup, cyclic group, cosets and Lagrange's theorem, permutation groups, normal subgroup, homomorphism and isomorphism of groups, congruence relation, rings and fields, example, and standard results.

**Coding Theory:** Elements of coding theory, Hamming metric, parity-check and generator matrices, coding and error detection, Group codes: decoding with coset leaders and error correction, Hamming matrices.

**UNIT IV: Partially Ordered Structures:**

**8 hours**

**Posets:** Definitions, ordered set, Hasse diagram, isomorphic ordered set, well ordered set, minimal and maximal elements, LUB & GLB etc.

**Lattices:** Definition & properties, product lattices, isomorphic lattices, applications, types of lattices.

**Boolean Algebras:** Definitions & properties, SOP & POS forms, logic gates and minimization of circuits, Karnaugh maps, Quine-McClusky method.

**Trees:** Definition & examples and properties, rooted tree, binary tree, tree traversal, application in computer science and engineering.

**UNIT V: Combinatorics and Graph Theory:**

**8 hours**

**Combinatorics:** Discrete numeric functions and properties, recurrence relations and their applications (modeling), various methods of solutions, system of recurrence relations, OGF & EGF, properties, applications: solution of recurrence relations and combinatorial problems.

**Graphs:** Graphs and graph models, terminology, matrices associated with graphs, isomorphism, special types of graphs, connectedness, Euler and Hamilton graphs with their applications, trees with properties, MST, planer graphs and applications, criteria of planarity, graph coloring and coloring models, directed graphs.



### Textbooks:

1. Trembley, J.P. & R. Manohar, "Discrete Mathematical Structures with Applications to Computer Science", Mc Graw Hill.
2. Kenneth H. Rosen, "Discrete Mathematics and its Applications", McGraw Hill.
3. Ralph, P. Garimaldi, "Discrete & Combinatorial Mathematics" Pearson Publication, Asia.
4. Deo, Narsingh, "Graph Theory with applications to Engineering & Computer Science", PHI.

### Reference Books:

1. Krishnamurthy, V., "Combinatorics Theory & Application", East-West Press Pvt. Ltd., NewDelhi.
2. Davey, B. A., & Priestley, H. A. (2002). Introduction to lattices and order (2nd ed.). Cambridge University press, Cambridge.
3. Goodaire, Edgar G., & Parmenter, Michael M. (2011). Discrete Mathematics with graph theory (3rd ed.). Pearson Education (Singapore) Pvt. Ltd. Indian Reprint.
4. Lidl, Rudolf & Pilz, Gunter. (2004). Applied Abstract Algebra (2nd ed.), Undergraduate Texts in Mathematics. Springer (SIE). Indian Reprint.

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## R for Data Science

Course Code: NMA-218

L-T-P-C: 2-0-2-3

**OBJECTIVE:** The objective of this course is to educate the students about:

- Fundamental Concepts of R Programming and Data Structures in R.
- Control Structures and Data Interfaces in R.
- R Packages for Data Science.



### Course Outcomes:

	On satisfying the requirements of the course and upon its successful completion, students will have knowledge/skills/competency to:	
CO 1	state, explain and use data types, functions in R to develop R scripts.	K1, K5
CO 2	state, explain and use data structures in R and operations to develop R programs.	K2, K5
CO 3	state, explain and use control structures in R to develop R programs.	K3, K5
CO 4	apply R packages for data tidying, data manipulation and data visualization.	K2, K3
CO 5	apply R packages for statistical computing, machine learning models, web crawling and dynamic report generation.	K5

### Course Articulation Matrix (CO-PO Matrix)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	-	-	1	2	2	-	2
CO2	3	3	2	1	3	-	-	1	2	2	-	2
CO3	3	3	2	1	3	-	-	1	2	2	-	2
CO4	3	3	2	1	3	-	-	1	2	2	-	2
CO5	3	3	2	1	3	-	-	1	2	2	-	2
Average	3	3	2	1	3	-	-	1	2	2	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) if there is no correlation, put“-“


  
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## SYLLABUS

**UNIT-I: Fundamentals of R Language:** Introduction, R installation, R uses, Installing R Studio, Identifiers, Constants, Variables, %O% Operations, Comments, Strings and Vectors, Data types and R Objects, Functions: User-defined, Built-in, and Embedded, Mathematical Character, Statistical, Recursive Data & Control Structures,

**UNIT-II: Data Structures in R:** To create, access, modify, delete, and merge Lists, Matrices, Arrays, Factors, and Data Frames, Operations and Arithmetic on Lists

**UNIT-III: Control Structures and Data Interactions:** Decision-making statement: if, else statement, nested if, else statement, for, while, function, S-Loop- structures: repeat loop, while loop, for loop, Break, Continue statements: Break Next statement Graphs & Charts

**Connecting R external interfaces:** Read/Write CSV, Excel, F, Del, TXT, JSON, Binary files and access to MySQL Database, Data Manipulation Tables, Read Data from Web, OOPs.

**UNIT-IV: R Packages for Data Science -1:** Introduction, Installation/Loading, Features and Applications of tidyverse, ggplot2, purrr, dplyr, readr, read\_csv, data.table, Janitor, shiny, plotly, lattice, ggvis, g, force, plotly, rmarkdown, rshiny, readr

**UNIT-V: R Packages for Data Science -2:** Introduction, Installation/Loading, Features and Applications of tidymodels, rbridate, mlr, cor, caret, W, tidyquant, RMarkdown.

**LAB WORK:** Development and execution of any 3-4 projects from each unit on the programming concepts and implementation of any 4-5 packages from each of unit.

### Text Books:

1. Cotton M., Learning R: a step-by-step functional guide to R Analysis, First Edition, Reilly Media Inc.
2. Roger D. Peng, R Programming for Data Science, Learning Publishing

### Reference Books

1. Gardener, M., Beginning R: The Statistical Programming Language, Wiley.
2. Matloff, N., The art of R Programming (A Tour of Statistical Software Design), No Starch Press, 11.

Any other textbook recommended by the instructor.

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## Data Science Lab-2

Course Code: NMA-220

L-T-P-C: 0-0-4-2

**OBJECTIVE:** The objective of this course is to educate the students about:




- Application of visualization techniques and statistical methods for EDA.
- Use of Hypothesis tests and time series models.
- Applications of machine learning algorithms to solve real-world problems.

	On satisfying the requirements of the course and upon its successful completion, students will have knowledge/ skills/ competency to:	
CO 1	Interpret data /big data using visualization packages in R	K3, K5
CO 2	Perform EDA: description, correlation and regression analytics using R packages	K2, K5
CO 3	Apply hypothesis tests of significance and time series models.	K5
CO 4	Implement Dimensionality Reduction and clustering using R.	K5
CO 5	Implement Regression and classification using R.	K5

### Course Articulation Matrix (CO-PO Matrix)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	-	-	1	2	2	-	3
CO2	3	3	2	1	3	-	-	1	2	2	-	3
CO3	3	3	2	1	3	-	-	1	2	2	-	3
CO4	3	3	2	1	3	-	-	1	2	2	-	3
CO5	3	3	2	1	3	-	-	1	2	2	-	3
Average	3	3	2	1	3	-	-	1	2	2	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) if there is no correlation, put“-“



  
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# SYLLABUS

Implementation of the following algorithms / techniques using R/Tableau/power BI

- Advanced data visualization techniques.
- Basic statistical methods.
- Hypothesis tests of significance, parametric and non-parametric tests.
- Time series models.
- Dimensionality Reduction and clustering.
- Regression and classification.
- Naïve Bayes / KNN/SVMs.
- Decision tree /Ensemble techniques/ text mining.

**LAB WORK:** 20-30 R Codes of real life problems are to be developed and executed.

### References:

1. Bharti Motwani "Data Analytics with R", Wiley.
2. Peng, R. "Exploratory Data Analysis with R", Lean Publishing.
3. Pearson, R. K. "Exploratory Data Analysis Using R", CRC Press.
4. Baclawski, K. "Introduction to Probability with R", CRC Press.

Any other textbook recommended by the Instructor.

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