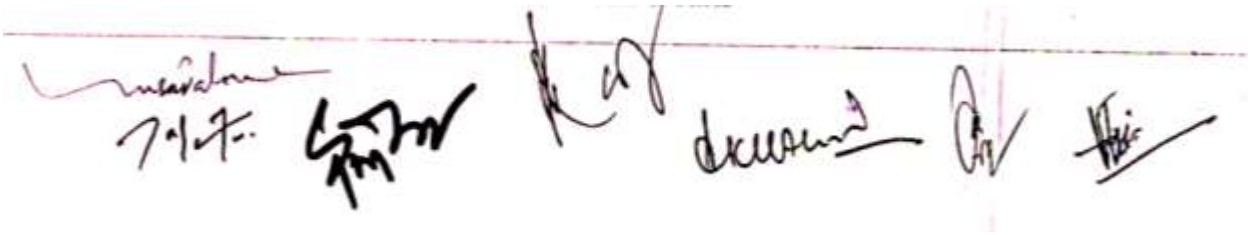
JK Institute of Mathematical Sciences

Choice Based Credit System (CBCS)

Syllabus 2020 Onwards

Semester	Core Course-CR Total Credits = 06 Theory = 04 Practical/ Tutorial = 02	Ability Enhancement Compulsory Course -AECC Total Credits = 04	Skill Enhancement Course -SEC Total Credits = 04	Discipline Specific Elective-DSE Total Credits = 06 Theory = 04 Practical/Tutorial = 02	Generic Elective -GE Total Credits = 06 Theory = 04 Practical /Tutorial = 02	Total Credits
I.	1. Calculus IMTH101CR 2. Computer Essentials for Data Sciences IMTH102CR	Environmental Sciences IMTH103AECC			Electricity and Magnetism IMTH104GE/Statics IMTH105GE	22
II.	1. Differential Equations IMTH201CR 2. Python for Data Analytics IMTH202CR	Communicative English IMTH203AECC			Mechanics and Thermal Physics IMTH204GE/Dynamics IMTH205GE	22
III.	1. Plane and Solid Geometry IMTH301CR 2. Abstract Algebra IMTH302CR 3. Data ware House Big Data Analytics IMTH303CR		Descriptive Statistics IMTH304SEC		Classical and Statistical Mechanics IMTH305GE/Solid State Physics-I IMTH306 GE	28
IV.	1.Real Analysis IMTH401CR. 2.Matrix and Linear		Disaster Management IMTH		Elements of Modern Physics IMTH406GE / Solid State	28

	Algebra IMTH402CR. 3. Machine Learning IMTH403CR.				Physics-II IMTH407GE	
V.	1.Advanced Calculus IMTH501CR. 2. Number Theory and Theory of Equations IMTH502CR			1.Probability Theory IMTH503DSE. 2.Discrete Mathematics IMTH504DSE		24
VI.	1.Complex Analysis IMTH601CR. 2.Metric Space IMTH602CR			1.Mathematical Modeling and Operations Research IMTH603DSE 2.ProjectIMTH604DSE		24
Total Credits						148



5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Calculus

Course Code: IMTH101CR **Total Credits: 06**
Max. Marks: 90 **Theory: 04**
Min. Marks: 36 **Prectical/Tutorial: 02**

Objectives: *Calculus is one of the major branches of mathematics which finds applications in all sciences. The course is an introduction to calculus where the students will be given the basics of differentiation, integration and the applications of both.*

UNIT I

Limit of a function, basic properties of limits, continuous functions and applications. Differentiability of a function, Rolle's theorem, Mean value theorems and applications. Taylor's theorem and Maclaurin's theorem with applications, L-Hospital's rule, successive differentiation, Leibnitz theorem with applications.

UNIT II

Tangents and Normals (polar form), pedal equations, length of arcs, Curvature, Envelops, involutes and evolutes. Partial Differentiation, Euler's theorem on homogenous functions, Asymptotes, Maxima and Minima, singular points, curve tracing.

UNIT III

Review of methods of integration, Integration of irrational functions, Reduction formulae: $\int \sin^n x dx, \int \cos^n x dx$, $\int \sin^n x \cos^n x\, dx$, $\int x^m (a+b x^n)^p dx$, , $\int x^m \cos nx dx$, $\int \cos^m x \cos^n x\, dx$, $\int \sin^m x \sin^n x\, dx$. Definite integral as a limit of a sum, properties of definite integrals. Beta and Gamma functions and their relations.

UNIT IV

Rectification: Length of arc of a curve, arc formula for Cartesian equations, length of arc when the limits of integration are not given, arc formula for parametric equations and polar equations.

Quadrature: Area formula for Cartesian equations, area between two curves $y=f(x), y=\varphi(x)$, area formula for parametric equations, area between two curves $r=f(\theta), r=\varphi(\theta)$, Pappus Guldinus theorem.

Books Recommended:

1. A. Auzeem, S.D. Chopra and M.L. Kochar, Differential Calculus, Kapoor sons.
2. T. M. Apostol, Calculus -I & II, Wiley International.
3. S. Lang, A First Course in Calculus, Springer-Verlag.
4. S.D. Chopra and M. L. Kochar, Integral Calculus, Kapoor Sons.

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Computer Essentials for Data Sciences

Course Code: IMTH102CR **Total Credits: 06**
Max. Marks: 90 **Theory: 04**
Min. Marks: 36 **Prectical/Tutorial: 02**

Objectives: *The objectives of this course is to introduce the students with the basic knowledge of data representation in computer system architecture and storage mechanisms.*

UNIT I

Number Systems, Conversions, Operations on Binary Arithmetic, data Representation, Define Data, Types of Variables: Determine nature of variables in data analysis - Differentiate between numerical and categorical. Variables - Distinguish between nominal and ordinal variables - Differentiate between interval and ratio - Distinguish between continuous and discrete data. Central Tendency/variability of Data: mean/median/mode weighted/geometric/harmonic means, range, quartiles, variance, standard deviation, Curve fitting – Principle of least squares – Fitting of straight line, parabola, exponential and power curve.

UNIT II

What is a Database? Database Objects, Tables, Records, Types of Database Management Systems, RDBMS, and SQL/Relational Databases vs. No SQL Databases, Introduction to SQL - Syntax, Data Types, Operators, Expressions, Comments, Data Definition Language (DDL), Data Manipulation Language (DML) & Data Control Language (DCL) Commands, Brief overview of Queries, Sub-Queries, Joins, Indexes, Transactions.

UNIT III

Data representation, Data organization, Data models using UML, Types of Data, structured, unstructured, semi structured, examples of real-world data, data collection techniques, data interpretation mechanisms. Data storage mechanisms, Hierarchy of storage, Characteristics of storage, Storage media, and storage related technologies, online and offline storage mechanisms

UNIT IV

Foundation of Data science, Area and Scope of Data Science, Steps of Data Science Process: Data collection, Preprocessing, training, and testing. Introduction to Data Mining and Machine Learning, Supervised, Unsupervised and Reinforcement learning. Prediction vs Classification v/s Clustering. Association Rule Mining, classification and regression techniques.

Books Recommended:

1. J. Glenn Brookshear,‖Computer Science: An Overview‖, Addision-Wesley, Twelfth Edition, 2014.
2. Ramez Elmasri, U. Shamkant B. Navathe, Fundamentals of Database Systems, 7th Edition.
3. Grady Booch, James Rumbaugh, Ivar Jacobson, The Unified modelling language Reference Manual.
4. Carl Hamacher, Zvonks Vranesic, SafeaZaky, Computer Organization, Vth Edition, McGraw Hill.
5. M.Moris Mano, Computer Systems Architecture, IIIrd Edition, Pearson/PHI

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Electricity and Magnetism

Course Code: IMTH104GE | **Total Credits: 06**
Max. Marks: 90 | **Theory: 04**
Min. Marks: 36 | **Prectical/Tutorial: 02**

Objectives: *The aim of this course is to use the understanding of calculus along with physical principles effectively solve problems in science and technology.*

UNIT I

Vector Analysis : (a) Vector Algebra: Addition of vectors and multiplication by a scalar. Scalar and vector products of two vectors.
(b) Vector Analysis: Gradient, divergence and Curl. Vector integration, line, surface and volume integrals of vector fields. Gauss 'divergence theorem and Stoke's theorem of vectors (Statement only) and their significances

UNIT II

Electrostatics : Coulomb's law, Gauss's law in integral and differential form, electric potential and relation with E, electrostatic energy density, dielectrics, Relation between E, D and P vectors, dielectric susceptibility, boundary conditions on E and D.
Magnetism: Motion of charged particles in electric and magnetic fields, Biot-Savart law, Ampere's law in integral and differential form, applications, Hall effect.
Types of magnetism – diamagnetism, paramagnetism and ferromagnetism, Weiss field, domains, magnetic permeability and susceptibility, Relation between B, H and M vectors, boundary conditions on B and H, hysteresis.

Unit III

Method of Images: Laplace's and Poisson equations, Uniqueness Theorems, Method of Images and its application to: Plane Infinite metal sheet, Semi-infinite dielectric medium and metal Sphere.

Unit IV

Electrodynamics: Faraday's law of electromagnetic induction in integral and differential form, Inductance, magnetic energy density, continuity equation for charge, displacement current, Maxwell's equations in free space, electromagnetic wave equation for plane waves in dielectric medium and free space, relation between $\boldsymbol{E}$, $\boldsymbol{B}$,and $\boldsymbol{k}$, Poynting vector, radiation pressure.

Books Recommended:

1. C. R. Dasgupta, Asok Kumar Das, A Handbook of Degree PHYSICS (Vol II), Book Syndicate Private Limited.
2. Edward M. Purcell, Electricity and Magnetism, 1986, McGraw-Hill Education.
3. D C Tayal, Electricity and Magnetism, 1988, Himalaya Publishing House
4. Electricity and Magnetism; R.Murugeshan; S. Chand Publishing.
5. Resnick & Walker , Fundamental of Physics: Halliday, (6th Edition)
6. William Hayt, John Buck, Engineering Electromagnetics, McGraw-Hill Companies (7th Edition)
7. Dasgupta, Das, Paul, A handbook of Degree Practical Physics (Vol 2), Book Syndicate Private Limited.
8. P.R. Sasi Kumar, Practical Physics, PHI Learning Private Limited.
9. Harnem Singh, P.S. Hemne, B.Sc. Practical Physics, S Chand and Company Limited.
10. C.L. Arora, B.Sc. Practical Physics, S Chand and Company Limited.
11. B. Ghosh, K.G.Majumdar, Practical Physics, Shreedhar Publishers.

List of Practicals:

1. Determination of unknown resistance by Carey Foster method.
2. Conversion of an ammeter to a voltmeter.
3. Conversion of a voltmeter to an Ammeter.
4. To determine an unknown Low Resistance using Potentiometer.
5. To determine the electrical equivalent of heat.
7. B-H curve and hysteresis loss.

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Statics

Course Code: IMTH105GE | **Total Credits: 06**
Max. Marks: 90 | **Theory: 04**
Min. Marks: 36 | **Prectical/Tutorial: 02**

Objectives: *In this course the students will be intruduced to forces, resultant of forces and parallelgam law. The course also intends to introduce friction, laws of friction and its types.*

UNIT I

Composition and resolution of forces, resultant. Parallelogram law of forces. Equilibrium of concurrent forces in a plane. Triangle law of forces.Lami's theorm and its applications. Coplanar forces acting at a point. Conditions of equilibrium of any number of coplanar concurrent forces.

UNIT II

Parallel forces. Like and unlike parallel forces. Moments, Varignan's theorem on moments.

UNIT III

Couples, equilibrium of two couples, resultant of a single force and couple. Equilibrium of three forces acting on a rigid body.

UNIT IV

Friction, force of friction, types of friction, laws of friction, coefficient of friction. Problems on equilibrium of ladders. Centre of gravity, centre of gravity of a uniform rod.

Books Recommended:

1. M. L. Kochar, A text Book of Statics, Kapoor Sons.
2. Gupta, S. Chand Elementary Statics.
3. R. C. Hibbler, Stattics and Dynamics, 7th Edition, Prientice Hall.
4. Shames, Rao, Engineering Mechanics, Pearson Education India.

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Differential Equations

Course Code: IMTH201CR | **Total Credits: 06**
Max. Marks: 90 | **Theory: 04**
Min. Marks: 36 | **Prectical/Tutorial: 02**

Objectives: *Differential equations play a vital role in engineering and sciences with regard to the applications. In this course the students will be tought about the various solutions of the differential equations.*

UNIT I

Formation of a differential equations by elimination, complete primitive, particular integral and singular solution of a differential equation. First order and first degree differential equations- exact equations, integrating factors and variables separable. Homogeneous equations of first order and degree one. Bernoulli's type differential equations. Necessary and sufficient condition for a differential equation $Mdx + Ndy = 0$ to be exact.

UNIT II

Symbolic operators: Homogenous and non-homogenous linear differential equations with constant and variable coefficients. Equations of the second order, auxiliary equations with -- imaginary and complex roots, equal roots, the complimentary function and particular integral, miscellaneous forms, Clairaut's form and equations reducible to Clairut's form.

UNIT III

Simultaneous and total differential equations: Solution of equations of the form dx/P = dy/ Q = dz/R using the method of inspection and multiplier, a second integral based on first integral, geometrical interpretation of the simultaneous system of equations. Total differential equations Pdx + Qdy + Rdz = 0, method of integration when it is integrable, method of solution by treating one variable constant, condition for integrability (statement only).

UNIT IV

Formation of partial differential equations by the elimination of arbitrary constants and functions, order and degree of partial differential equations, concept of linear and non-linear partial differential equations, linear partial differential equation of first order, Lagrange's method, Geometrical interpretation of the partial differential equation of the form Pp + Qq = R,

Classification of second order partial differential equations into elliptical, parabolic and hyperbolic through illustrations only.

Books Recommended:

1. G. F. Simmons, Ordinary Differential Equations with Applications, Tata MCGraw.
2. N. Sneddon, “Elements of partial Differential Equations” Dover Publications, New York 2006.
3. F. John, “Partial Differential Equations” Springer-Verlag, New York, 1982.
4. D.A. Murray, “Introductory Course in Differential Equations” Orient Longman (India),1967.
5. H. T. H. Piaggio, An Elementary Treatise on Differential Equations and their Applications, CBS Publishers, New Delhi.
6. L. C. Evans, Orient Black Swan Partial Differential Equations, 2nd edition.

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Python for Data Analytics

Course Code: IMTH202CR **Total Credits: 06**
Max. Marks: 90 **Theory: 04**
Min. Marks: 36 **Prectical/Tutorial: 02**

Objectives: *The aim of this course is to provide basic knowledge of Python and its use in scripting language for developers.*

UNIT I

Python Basics: Python Programming Language Data and Expressions: Literals, Variables and Identifiers, Operators, Expressions, Statements and Data Types Control Structures: Boolean Expressions (Conditions), Logical Operators, Selection Control, Nested conditions.
Iteration: While statement, Definite loops using For, Loop Patterns

UNIT II

Advanced Constructs in Python: Lists: List Structures, Lists (Sequences), Iterating Over Lists (Sequences).
Exception Handling, working with numbers, strings, Date and Times. Dictionaries, set, tuple, Functions: Fundamental Concepts, Program Routines, Flow of Execution, Parameters & Arguments, Recursive Functions, object oriented programming in python, python mysql database programming.

UNIT III

Essential Python Libraries: Essential Python libraries: scipy, scikit, Numpy basics, Arrays and Vector Computation, Numpy nDArray, Data processing using arrays(the Series Data Structure), Querying a Series, The DataFrame Data Structure, Dataframe Indexing and Loading, Querying a Dataframe, Indexing Dataframes,
Importing and Exporting Data in Python -- Data loading, Reading and writing data in Text/ Binary formats, Data wrangling with Pandas: Data exploration — columns, unique values in a column, describe, duplicates, dealing with missing values — quantifying missing values per column, filling & dropping missing values. Reshaping data (Data Formatting) — one hot encoding, pivot tables, joins, grouping and aggregating, Filtering data.

UNIT IV

Data Plotting and Visualization: Matplotlib library, Data plotting and visualization, Plots, subplots, Colors, Markers, and Line Styles, Setting the

title, axis labels, ticks, and ticklabels, legends, Annotations and Drawing on a Subplot, Saving Plots to File, Plotting Functions in pandas (Line, Bar, Histograms and Density Plots, Scatter Plots).

Books Recommended:

1. Charles Severance, Python for Informatics, version 0.0.7.
2. Oreilly, Wes Mc Kinney , Python for Data Analytics.
3. Oreilly, Joel Grus, Data Sciences from scratch.
4. Michel Urban, Joel Murach, Murach's Python Programming.
5. Introduction to Computer Science Using Python: A Computational Problem-Solving Focus,
6. Charles Dierbach, Wiley Publications, 2012, ISBN: 978-0-470-91204-1
7. Guttang John V, Introduction to Computation and Programming Using Python, PHI, 2014, ISBN-13: 978-8120348660

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Mechanics and Thermal Physics

Course Code: IMTH204GE **Total Credits: 06**
Max. Marks: 90 **Theory: 04**
Min. Marks: 36 **Prectical/Tutorial: 02**

Objectives: *To learn the fundamentals of dynamics and analyse the bodies which are in motion using the basics of kinetics and kinematics. Also to give students an understanding of oscillations and waves and their essence in the study of physics.*

UNIT I

Fundamentals of Dynamics: Reference frames. Inertial frames; Galilean transformations; Galilean invariance. Review of Newton's Laws of Motion. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. Momentum of variable-mass system: motion of rocket.
Work and Energy: Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy, Force as gradient of potential energy. Work & Potential energy, Work done by non-conservative forces. Law of conservation of Energy.

UNIT II

Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.
Elasticity: Relation between Elastic constants. Twisting torque on a Cylinder or Wire.
Fluid Motion: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

UNIT III

Oscillations: S H M: Simple Harmonic Oscillations. Differential equation of SHM and its
solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.
Waves: Plane waves — Spherical Waves-Harmonic Waves - Phase Velocity - Wave packets - Group Velocity - Plane Electromagnetic Waves: Linear, Circular, and Elliptic Polarizations -Stokes Parameters, Polarisers.
Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications.

UNIT IV

Thermal Physics: The laws of Thermodynamics, Thermodynamic Potentials, Clausius - Clayperon equation, Equation of State - Description of Phase Transitions -Surface Effects in Condensation -Van der Waals Equation of State - Joule- Thomson Cooling. Probability - General Definitions, One Random Variable, Some Important Probability Distributions - Many Random Variables. Microstates and Macrostates, Maxwell-Boltzmann Distribution - Most Probable Distribution, Partition function.

Books Recommended:

1. D. Kleppner, R.J. Kolenkow, An introduction to mechanics, 1973, McGraw- Hill.
2. C.Kittel, W.Knight, et.al. Mechanics, Berkeley Physics, vol.1, 2007, Tata McGraw-Hill.
3. Resnick, Halliday and Walker, Physics, 8/e. 2008, Wiley.
4. G.R. Fowles and G.L. Cassiday, Mechanics, 2005, Cengage Learning.
5. R.P.Feynman, R.B.Leighton, M.Sands, Feynman Lectures, Vol. I, 2008, Pearson Education
6. R. Resnick, Introduction to Special Relativity, 2005, John Wiley and Sons.
7. Ronald Lane Reese, University Physics, 2003, Thomson Brooks/Cole.

List of Precticals:

1. To determine g and velocity for a freely falling body using Digital Timing Technique
2. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille’s method).
3. To determine the Young's Modulus of a Wire by Optical Lever Method.
4. To determine the Modulus of Rigidity of a Wire by Maxwell’s needle.
5. To determine the elastic Constants of a wire by Searle’s method.
6. To determine the value of g using Bar Pendulum.
7. To determine the value of g using Kater’s Pendulum.

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Dynamics

Course Code: IMTH205GE **Total Credits: 06**
Max. Marks: 90 **Theory: 04**
Min. Marks: 36 **Prectical/Tutorial: 02**

Objectives: *The main objectives of this course is to study velocity, acceleration and Newtons laws in the analytic setting. The curvilinear coordinates and motion of projectiles will also be tought.*

UNIT I

Velocity and acceleration. Motion of a particle, velocity of a moving particle. Distance – time graph, velocity – time graph, motion with constant accelration, bodies falling vertically, bodies projected vertically upwards.

UNIT II

Newtons laws of motion, matter, mass and movementum. Rectilinear motion under uniform acceleration. Rectilinear motion. Relations between u, v, f, s and t., relation p=mfdistance travelled in the t th second, motion between two stops.

UNIT III

Variable accelrations, equation of a motion with initial and boundary conditions, simple harmonic motion (SHM), SHM as periodic motion, maximum and minimun velocities and accelrations.

UNIT IV

Curvilinear motion in a plane, projectiles, trajactory, velocity of projection. Angle of projection, time of flight, expressions for greatest height attained and time taken. Applications on projectiles.

Books Recommended:

1. M. R. Puri and B. L. Raina Elementary Dynamics, Kapoor Publications .

2. S. R. Gupta, S. Chand Elementary Analytical Dynamics.

3. Gupta Sant, S. Chand Elementary Analytical Dynamics.

5. R. C. Hibbler, Stattics and Dynamics, 7th Edition, Prientice Hall.

6. Shames, Rao, Engineering Mechanics, Pearson Education India.

5 Year Integrated Course in Mathematics-2021

JK Institute of Mathematical Sciences

Plane and Solid Geometry

Course Code: IMTH301CR | **Total Credits: 06**
Max. Marks: 90 | **Theory: 04**
Min. Marks: 36 | **Prectical/Tutorial: 02**

Objectives: *In this course the students will be exposed to planer curves viz parabola, hyperbola and ellipse. Space curves viz sphere, cylinder, cone will also be tought.*

UNIT I

Parabola: Equation of tangent and normal, pole and polar, equation of chord in terms of middle point, parametric equation of parabola. Ellipse: Tangents and normal, pole and polar, parametric equation of ellipse, diameter and conjugate diameter.

UNIT II

Hyperbola: Equation of tangent and normal, pole and polar, equation of chord in terms of middle point, parametric equation, Equation of hyperbola referred to asymptotes as axes, rectangular and conjugate diameter, tracing of conics, General second degree equation in x and y.

UNIT III

Sphere: condition for two spheres to be orthogonal. Radical plane. Coaxial system. Simplified form of the equation of two spheres. Cone: Vertex, guiding curve, generator, equation of cone with vertex as origin or a given vertex and guiding curve, condition that the general equation of the second degree should represent a cone. Angle between generators of section of a cone and plane through vertex. Necessary and sufficient conditions for a cone to have three mutually perpendicular generators.

UNIT IV

Cylinder: Equation of cylinder, enveloping cylinder of a sphere, central conicoids, tangent lines and tangent planes, normal to conicoid at a point on it, normal from a point to conicoid, shapes and features of the three central conicoids, diametric planes.

Books Recommended:

1. R. J. T. Bell , elementary treatise on coordinate geometry of 3 dimensions,mac millan
2. P. K. Jain and Khalil Ahmad ,a text book of analytical geometry of 3 dimensions , new age international publisher
3. D. Chattergi, analytical geometry of 2 and 3 dimensions
4. Shanti Narayan, analytical solid geometry, s.chand & sons.
5. S. Pirzada and T. A. Chishti, Analytical Solid Geometry, Universities Press, Orient Blackswan.

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Abstract Algebra

Course Code: IMTH302CR **Total Credits: 06**
Max. Marks: 90 **Theory: 04**
Min. Marks: 36 **Prectical/Tutorial: 02**

Objectives: *The aim of this course is to expose the students to abstract algebraic structures viz groups, permutations groups, homomorphism and isomorphisms, rings, ideals and PIR.*

UNIT I

Equivalence relations and equivalenece classes, integer modulo system, Binary composition. Groups, examples and simple properties, General linear groups, symmetries and formation of groups from the equivaleteral triangle and square. Examples of non-abelian groups. Subgroups and cosets, criteria for a non-empty subsets of a group to be subgroups, order of an element.

UNIT II

Lagrange's theorem for finite groups, cyclic groups, equality for the order of a group and the order of its generator, Permutation groups, Cayley's theorem, permuationa as a product of disjoint cycles and transpositions, Even and odd permutations. The alternating groups An. Order of an alternating group.

UNIT III

Group homomorphism and Isomorphism, Kernel of a homomorphism, fundamental theorem of homomorphism and theorems on isomorphism. Product of subgroups and condition for the product to be a group, counting principle. Normal subgroups and their properties, Quotient groups. Centre of a group and normalizer of an element in a group.

UNIT IV

Rings: Definition, examples of commutative and non-commutative rings, integral domains, zero divisors, subrings and ideals, definition of quasi-fields and fields, ring homomorphisms and isomorphism, kernel of a homomorphism, quotient rings, prime and maximal ideals, principal ideals and PIR's, relation

between maximal and prime ideals, ideals of nilpotent and radical elements, fundamental theorem of ring homomorphism.

Books Recommended:

1. M. Artin, Algebra, Prentice hall of India.
2. D. S. Dumit and R. M. Foote, Abstract Aldebra, John Wiley.
3. Joseph Gallian , Abstract Algebra, Narosa Publishers, New Delhi.
4. I. N. Herstein, Topics in Algebra, John Wiley.
5. P.B. Bhattachariya, S.K. Jain, S. R. Nagpaul, Basic Abstract Algebra, Cambridge.
6. Surjeet singh and Qazi Zameeruddin, Modern Algebra, New age International.
7. I. N. Jacobson , Basic Algebra , Hindustan publishing corporation.

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Dataware House Big Data Analytics

Course Code: IMTH303CR **Total Credits: 06**
Max. Marks: 90 **Theory: 04**
Min. Marks: 36 **Prectical/Tutorial: 02**

Objectives: *The main objective of the course is to review formal definitions of the dataware house and dataware house architecture. During the course conceptualization and summarization of big data and machine learning, trivial data versus big data, big data computing technologies, machine learning techniques and scaling up machine learning approaches.*

UNIT I

Data Warehouse Fundamentals: Introduction to Data Warehouse, OLTP Systems; Differences between OLTP Systems and Data Warehouse: Characteristics of Data Warehouse; Functionality of Data Warehouse: Advantages and Applications of Data Warehouse; Advantages, Applications: Top- Down and Bottom-Up Development Methodology: Tools for Data warehouse development, Data Warehouse Types.

UNIT II

Dara warehouse architectures, ETL (extract, transform and load), introduction to OLAP, OLAP creation process, OLAP advantages, Multidimensional data, data warehouse and OLAP.

UNIT III

Introduction to Big Data, Characteristics of Big Data, Evolution of Big Data, Challenges with Big Data, Big data sources, best practices in Big Data Analytics, Introduction to Data Modelling

Introduction to elementary data analysis: Measures of center: Mean, Median, Mode, Variance, Standard deviation, Range, Normal Distribution: Center, Spread, Skewed Left, Skewed Right,

Outlier, Correlation Patterns, Magnitude and Direction in relationship, Introduction to Bayesian Model

History of Visualization, Goals of Visualization, types of Data Visualization: Scientific Visualization, Information Visualization, Visual Analytics, Impact of visualization, Big Data Visualization Tools: Tableau, Google Chart

UNIT IV

Introduction to Big Data Processing and Apache Hadoop, Installation and Configuration of Hadoop in Ubuntu, HDFS Concepts, MapReduce Framework, Anatomy of a Map Reduce Job Run, Job Scheduling, Shuffle and Sort, Task Execution

Introduction to Hadoop Eco System, Apache Hive, Apache Mahout, Apache Pig, Case studies: Analyzing big data with twitter, Big data for Ecommerce, Big data for blogs.

Books Recommended:

1. Michael C. Reingruber, William W. Gregory —The Data Modeling Handbook: A Best Practice Approach to Building Quality Data Models‖, Wiley QED publications, First Edition.
2. Philip Bobko, —Correlation and Regression: Applications for Industrial Organizational Psychology and Management‖, First Edition.
3. Data warehouse toolkit – the definitive guide to dimentional modelling, 3rd edition: Ralph Kimbal.
4. Data warehouse, data mining and OLAP –Alex Berson, Stephen J Smith.
5. Seema Acharya, Subhasini Chellappan, "Big Data Analytics", Wiley, 2015
6. Frank J Ohlhorst, —Big Data and Analytics: Turning Big Data into Big Money‖, Wiley and SAS Business Series, 2012.
7. Tom White, — Hadoop: The Definitive Guide‖ Third Edition, O‘reily Media, 2012

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Descriptive Statistics

Course Code: IMTH304SEC **Total Credits: 04**
Max. Marks: 60 **Theory: 02**
Min. Marks: 24 **Prectical/Tutorial: 02**

Objectives: *This course highlights the basic concepts of statistics including the different of Measures of Central Tendency, Measures of Dispersion, Regression and Correlation Analysis and Index Numbers which primarily focus on organizing, displaying and describing data.*

UNIT I

Types of Measurement Scale. Measures of central tendency: Mean, Median, Mode, Quartiles, Deciles, Percentiles, Geometric Mean, and Harmonic Mean. Measures of Dispersion, moments, Range, Mean Deviation, Quartile Deviation, Standard Deviation, Coefficient of Variation. Measures of Skewness: Karl Pearson's and Bowley's Method. Measures of Kurtosis and Sheppard's corrections.

UNIT II

Correlation Analysis – conceptual frame work. Methods of studying correlation – scatter diagram, Karl Pearson's correlation coefficient, Spearman's rank correlation coefficient and concurrent deviation methods. Probable error (ungrouped data), coefficient of determination. Principle of least squares and fitting of polynomials and exponential curves. Regression Analysis-definition and uses, simple linear regression, regression equations and regression coefficient, properties of regression coefficient.

Books Recommended:

1. B. R., Srivenkatramana, T. and Rao Madhava, K. S.,Statistics: A Beginner;s Text, Bhat, New Age International (P) Ltd.
2. Croxton, F. E., Cowden, D. J. and Kelin, S., Applied General Statistics, Prentice Hall of India.
3. Theory & Problems of Statistics, Spiegel, M. R., Schaum's Publishing Series
4. Gupta, S. C. and Kapoor, V. K., Fundamental of Applied Statistics, Sultan Chand and Sons.
5. Gupta, S. C. and Kapoor, V. K.,Fundamental of Mathematical Statistics, Sultan Chand and Sons.

6. Anderson, T. W. and Sclove, S. L. : An Introduction to Satatistical Analysis of Data, Houghton Miffin/Co.

Practicals

1. Practical based on Arithmetic Mean with Different Formulas.
2. Practical based on calculation of Median in Continuous Data
3. Practical based on Quartiles, Deciles and Percentiles.
4. Practical based on calculation of Mode for continuous Data.
5. Practical based on calculation of Standard Deviation and Variance Using Different Formula
6. Practical based on calculation of Mean Deviation, Range, Quartile Deviation and Coefficient of Variation.
7. Practical based on Skewness using Different Formulas
8. Practical based on Kurtosis.
9. Practical based on moments and Sheppard's Correction.
10. Practical based on calculating Correlation Coefficient.
11. Practical based on Calculating Spearman's Correlation Coefficient.
12. Practical based on obtaining two lines of Regression and Regression Coefficients.

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Classical and Statistical Mechanics

Course Code: IMTH305GE **Total Credits: 06**
Max. Marks: 90 **Theory: 04**
Min. Marks: 36 **Prectical/Tutorial: 02**

Objectives: *The aim of this course is to give the students a through understanding of the theory and methods of statistical physics and to demonstrate fundamental concepts in the dynamics of system of particles, motion of rigid body, lagrangian and hamiltonian.*

UNIT I

Classical Statistics: Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Law of Equipartition of Energy.

UNIT II

Quantum Theory of Radiation: Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law.
Bose-Einstein Statistics: B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation.
Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy

UNIT III

Classical Mechanics: Classical Mechanics of Point Particles: Generalised coordinates and velocities. Hamilton's Principle, Lagrangian and Euler-Lagrange equations. Applications to simple systems such as coupled oscillators. Canonical momenta & Hamiltonian. Hamilton's equations of motion. Applications: Hamiltonian for a harmonic oscillator, particle in a central force field. Poisson brackets. Canonical transformations.

UNIT IV

Special Theory of Relativity: Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation.

Relativistic transformation ofvelocity, frequency and wave number. Relativistic addition of velocities.

Books Recommended:

1. M.W. Zemansky, Richard Dittman, Heat and Thermodynamics, 1981, McGraw-Hill.
2. Meghnad Saha, and B.N.Srivastava, A Treatise on Heat, 1958, Indian Press
3. S. Garg, R. Bansal and Ghosh, Thermal Physics, 2nd Edition, 1993, Tata McGraw-Hill
4. Statistical Physics: Berkeley Physics Course, Vol. 5, by F. Reif; Tata-McGraw Hill.
5. Kerson Huang, Statistical Mechanics , Wiley Eastern.

PHYSICS PRACTICAL

Use C/C++/Scilab for solving the problems based on Statistical Mechanics like

1. Plot Planck's law for Black Body radiation and compare it with Wein's Law and
Raleigh-Jeans Law at high temperature (room temperature) and low temperature.
2. Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature (room temperature) and low temperature and compare them for these two cases
3. Plot Maxwell-Boltzmann distribution functions versus temperature.
4. Plot Fermi-Dirac distribution functions versus temperature.
5. Plot Bose-Einstein distribution functions versus temperature.

Reference Books:

1. K.E.Atkinson, Elementary Numerical Analysis, 3 r d Edn. 2007, Wiley India Edition
2. R.K. Pathria, Butterworth Heinemann, Statistical Mechanics, 2nd Ed., 1996, Oxford University Press.
3. Francis W. Sears and Gerhard L. Salinger, Thermodynamics, Kinetic Theory and Statistical Thermodynamics, 1986, Narosa.
4. Carl S. Helrich, Modern Thermodynamics with Statistical Mechanics, 2009, Springer

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Solid State Physics I

Course Code: IMTH306GE **Total Credits: 06**
Max. Marks: 90 **Theory: 04**
Min. Marks: 36 **Prectical/Tutorial: 02**

Objectives: *This course gives an introduction to the solid state physics and will enable the students to employ classical and quantum mechanical theories needed to understand the physical proprities of solids.*

UNIT I

Crystal Structure Defects: Crystalline state of solids, Lattice Translation Vector, Unit cell, Wigner- Seitz cell, Number of lattice point per unit cell, packing fraction, Bravais lattice, Miller indices, Interplaner spacing, Symmetry elements, types of lattices, Brillouin zone, reciprocal lattice. Point defects-Frenkel and Schottky vacancies, Line defects-Edge and screw dislocations, Planer defects, Stacking faults

UNIT II

X-rays and Atomic Bonding: X-Rays: Continuous and characteristic X-rays spectra, Absorption of X-rays, Diffraction of X-rays, Bragg's law, Laue's equations, Powder method. Atomic Bonding: Interatomic forces and classification of solids, Bond dissociation Energy, Cohesive Energy of ionic crystal, Types of Bonds; Ionic bond, Covalent bond, Metallic Bonding, Van der Waals Bonding

UNIT III

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic molecules chains, Acoustical and Optical Phonons, Qualitative Description of the Phonon spectrum in solids, Dulong and Petit law, Einstein and Debye theories of specific heat of solids, Debye T^3 law.

UNIT IV

Electrical Conductivity: Free electron theory, Sommerfeld model, Fermi level, Density of states, Electrical conductivity of metals and its temperature dependence, Weidemann-Franz law, Hall Effect.

Books Recommended:

1. Charles Kittle, Introduction to Solid State Physics, 8th edition, Wiley India 2004.
2. Rita John, Solid state physics, McGraw Hill, 2014.
3. Azaroff L. V, Introduction to Solids, Tata McGraw Hill 2004.
4. N.W. Ashcroft and N.D. Mermin, Solid State Physics, Saundars College Publishing, 1976.
5. H. Ibach and H. Luth, Solid-state Physics, Springer 2009.
6. J.P. Srivastava, Elements of Solid State Physics, Narosa Publications 2011.

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Real Analysis

Course Code: IMTH401CR **Total Credits: 06**
Max. Marks: 90 **Theory: 04**
Min. Marks: 36 **Prectical/Tutorial: 02**

Objectives: *The aim of the course is to make the students learn about the sequences and series of real numbers, variuos tests of convergence and the completeness property of R.*

UNIT I

Real numbers, Cardinality, Countable and uncountable sets, proof of the countability of rationals and of uncountability of reals, Schoeder-Bernstein theorem, Bounded and unbounded sets, L.u.b. and g.l.b. of a set of real numbers, Archimedean property, Dedekind's property, $\mathbb{R}$ as an ordered filed, completeness and the least upper bound property of $\mathbb{R}$, incompleteness of the set of rational numbers.

UNIT II

Sequences of real numbers: Bounds of a sequence, convergence of a sequence, Theorems on limit and convergence of sequences, bounded and monotonic sequences, Cauchy's criteria for convergence of sequences, limit and limit point of a sequence, nested interval theorem, Bolzano-Weierstrass theorem, monotonic sequences, subsequences,limit inferior and limit superior of a sequence.

UNIT III

Infinite series: Convergence and divergence of series, necessary condition for convergence of a series, Cauchy criteria for convergence of series, geometric series, series of positive terms, Comparison test, Cauchy's root test, D-Alembert's ratio test, Raabe's test, logrithemic test, Integral test and Gauss test, alternating series, Leibnitz test, absolute and conditional convergence.

UNIT IV

Riemann-Integration: Upper and lower sums, refinement of a partition, behaviour of lower sums and upper sums under refinement, necessary and sufficient conditions for R-integrability of a bounded function, algebra of of R-integrable functions, R-integrability of $|f|$ for which f is bounded and R-

integrable on an interval, R- integrability of a function having a finite number of discontinuities and of continuous and monotone functions. Fundamental theorem of calculus, Primitive of a R-integrable function, Continuity and differentiability of the primitive, Lebesgue's criterion for R-integration.

Books Recommended:

1. S.C. Malik, Real Analysis, New Age International.
2. T.M.Apostol, Mathematical Analysis, Narosa Publications.
3. S.C. Malik, Mathematical Analysis, New Age International.
4. W. Rudin, Real and Complex analysis, Mcgraw Hill.
5. R. Goldberg, Methods of Real Analysis, Oxford IBM Publication 1970.

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Matrix and Linear Algebra

Course Code: IMTH402CR **Total Credits: 06**
Max. Marks: 90 **Theory: 04**
Min. Marks: 36 **Prectical/Tutorial: 02**

Objectives: *This course is a requirement for advanced studies in mathematics and engineering as it provides the basis for the same.The course is to make the students learn about matrices, vector spaces and linear operators.*

UNIT I

Riview of Matrices; Generalization of reversal law of transpose, Hermitian and skew-symmetric (skew- Hermitian) matrices, result on adjoint, every square matrix can be uniquely expressed as $P + iQ$, where P and Q are both Hermitian matrices, Inverse of a square matrix, Reversal law for the inverse of product of two matrices, condition for existence of inverse of a square matrix. The operation of transposing and inverting are commutative, Trace of a matrix, Trace of AB= Trace of BA and its generalization.

UNIT II

Matrix polynomials, Characteristic and minimal equations of a matrix, partitioning of matrices, Cayley Hamilton theorem, eigen valus and eigen vectors, rank of a matrix, Elementary row(Column) Transformations of a matrix do not alter its rank, rank of a matrix by elementary transformations, reduction of a matrix to the normal form, Elementary matrices. Every non-singular matrix is a product of elementary matrices, employment of only row (column) transformations. Rank of product of two matrices.

UNIT III

Linear dependence and linear independence of Row (Column) vectors, Linear combination, The columns of a matrix A are linearly dependent iff there exists a vector $X \neq 0$ such that AX=0. The columns of a matrix A of order $m \times n$ are linearly dependent iff rank of A< n .The matrix A has rank r iff it has r linearly independent columns (analogous results for rows). Linear homogeneous and non- homogeneous equations, The equation AX=0 has a non-zero solution iff rank of A < n, the number of its columns, The number of linearly independent solutions of the equation AX=0 is n-r, where r is the rank of matrix A of order $m \times n$, The equation AX=B is consistent iff two matrices A and [A: B] are of the same rank. Inner product of two vectors, length of a vector, normal vectors, Orthogonal and Unitary matrices, A matrix P is orthogonal (Unitary)

iff its columns are normal and orthogonal in pairs, Determination of orthogonal matrices.

UNIT IV

Vector (linear) space, definition and examples (spanning sets and subspaces, linear span, direct sum of subspaces, quotient spaces. Linear combinations, linear dependence and linear independence, basis and dimensions of a vector space, linear functionals. Linear transformations, kernel of linear transformation, rank and nullity of linear mapping, singular and non singular linear mappings, isomorphisms, operations with linear mappings, Algebra of linear transformations and related results. Matrix representation of linear operator, change of basis matrices and related results.

Books Recommended:

1. A Text book of matrices, Aziz et.al, KBD.
2. A text book of Matrices, Shanti Narayan, S. Chand.
3. K. Hoffman and R. Kunze, Linear Algebra, Pearson Education.
4. Linear Algebra, Schaum"s outline series, Tata McGraw-Hill.

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Machine Learning

Course Code: IMTH403CR **Total Credits: 06**
Max. Marks: 90 **Theory: 04**
Min. Marks: 36 **Prectical/Tutorial: 02**

Objectives: *The objective of this course is to learn about the basic theory under machine learning. During this course the student will be tought about applications of algorithims to the real world problems.*

UNIT I

Supervised and Unsupervised Learning.
Getting and Cleaning Data: Obtaining data from the web, from APIs, from databases and from colleagues in various formats. Basics of data cleaning and making data —tidy.
Data pre-processing: Descriptive Data Summarization, Data Cleaning, Data Integration and Transformation, Data Reduction, Data Discretization and Concept Hierarchy Generation.

UNIT II

Classification: Classification, Issues Regarding Classification, Classification by Decision Tree Induction, Bayesian Classification, Rule-Based Classification, Metrics for Evaluating Classifier Performance, Holdout Method and Random Sub sampling
Linear Regression: Prediction using Linear Regression, Gradient Descent, Linear Regression with one variable, Linear Regression with multiple variables, Polynomial Regression, Feature Scaling/Selection.
Logistic Regression: Classification using Logistic Regression, Logistic Regression vs. Linear Regression, Logistic Regression with one variable and with multiple variables.

UNIT III

Clustering: Cluster Analysis, Agglomerative versus Divisive Hierarchical Clustering, Distance Measures in Algorithmic, Evaluation of Clustering.
Regularization: Regularization and its utility: The problem of Overfitting, Application of Regularization in Linear and Logistic Regression, Regularization and Bias/Variance.
Prediction: Prediction, Issues Regarding Prediction, Accuracy and Error Measures, Evaluating the Accuracy of a Classifier or Predictor.

UNIT IV

Support Vector Machine, K-Nearest Neighbor methods and Bayesian networks.

Neural Networks: Introduction, Model Representation, Gradient Descent vs. Perceptron Training, Stochastic Gradient Descent, Multilayer Perceptrons, Multiclass Representation, Back propagation Algorithm.

Deep Learning: History, Scope and specification, building block of neural network, neural networks, Deep learning hardware. Feed forward neural networks, xor model, cost function estimation (maximum likelihood), units, activation functions, layers, normalization, hyper-parameter tuning.

Model selection, Model selection criteria, Description length, feature selection, combining classifiers, Current problems in machine learning.

Books Recommended:

1. Shalev-Shwartz, Shai, and Shai. Understanding machine learning: Cambridge university press
2. Duda, Richard O., Peter E. Hart, and David G. Stork. Pattern classification. John Wiley & Sons,
3. Witten, Ian H., et al. Data Mining: Practical ML tools and techniques. Morgan Kaufmann, 2016.
4. Ethem Alpaydin, "Introduction to Machine Learning" 2nd Edition, The MIT Press, 2009.
5. Tom M. Mitchell, "Machine Learning", First Edition by Tata McGraw-Hill Education, 2013.
6. Christopher M. Bishop, "Pattern Recognition and Machine Learning" by Springer, 2007.
7. Mevin P. Murphy, "Machine Learning: A Probabilistic Perspective" by The MIT Press, 2012.

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Numerical Analysis

Course Code: IMTH405SEC **Total Credits: 04**
Max. Marks: 60 **Theory: 02**
Min. Marks: 24 **Prectical/Tutorial: 02**

Objectives: *The course aims to make the students learn about finite differences, interpolation and computational methods to solve differential equations.*

UNIT I

Finite difference and Interpolation: Error estimation, finite differences forward, backward and central difference operator, and relation between them. Newton's difference formulae, Newton's divided difference formulas, Gauss forward and backward formulae, Lagrange's and Hermite interpolations formula.

UNIT II

Numerical solution of algebraic and transcendental equations: Basic concepts on polynomial equations, Roots of equations by Bisection method, iterative method, regula-falsi method, Newton – Raphson method, Secant method, Ramanujan method.

Books Recommended:

1. S. S. Sastary, "Introductory Numerical Analysis", Narosa publishing house.
2. M.K. Jain, S.R.K. Iyenger and R.K.Jain, "Numerical Methods for Scientific and Engineering Computation, Wiley Eastern Limited.
3. C.F. Gerald and P. O. Wheatley, "Applied Numerical Methods" Pearson Education Asia.

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Elements of Modern Physics

Course Code: IMTH406GE **Total Credits: 06**
Max. Marks: 90 **Theory: 04**
Min. Marks: 36 **Prectical/Tutorial: 02**

Objectives: *The aim of this course is to learn about the basic principles of modern physics and to build a foundation to understand advanced branches of modern physics.*

UNIT I

Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them.

UNIT II

Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle , Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- application to virtual particles and range of an interaction.

UNIT III

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension; One dimensional infinitely rigid box- energy eigen values and eigen functions, normalization; Quantum dot as example; Quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier.

UNIT IV

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay: energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission.

Books Recommended:

1. Arthur Beiser ; Concepts of Modern Physics, 2002, McGraw-Hill.
2. Rich Meyer, Kennard, Coop, Introduction to Modern Physics, 2002, Tata McGraw Hill
3. David J. Griffith, Introduction to Quantum Mechanics, 2005, Pearson Education.
4. Jewett and Serway, Physics for scientists and Engineers with Modern Physics, 2010,
Cengage Learning.
5. A.K.Ghatak & S.Lokanathan, Quantum Mechanics: Theory & Applications, 2004, Macmillan

PHYSICS PRACTICAL

1. Measurement of Planck’s constant using black body radiation and photo-detector
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light

3. To determine the wavelength of laser source using diffraction of single slit.
4. To determine the wavelength of laser source using diffraction of double slits.
5. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia
Publishing House
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition,
reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011,Kitab Mahal

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Solid State Physics II

Course Code: IMTH407GE **Total Credits: 06**
Max. Marks: 90 **Theory: 04**
Min. Marks: 36 **Prectical/Tutorial: 02**

Objectives: *This course is aimed to put emphasis on building models for explanning several different phenomena in solid state.*

UNIT I

Elementary Band Theory of Solids: Bloch Theorem, Electron in periodic field: Kronig Penney model, Brillouin zones, Effective mass of electron, Origin of Band Gap, Insulator, semiconductor and metals. Intrinsic and Extrinsic Semiconductors, Carrier concentration, Fermi level and conductivity for Intrinsic and Extrinsic Semiconductors

UNIT II

Magnetic Properties of Matter: Response of substance to magnetic fields, Dia, Para and Ferromagnetic materials, Absence of magnetic charge, Electric current in atoms, Electron spin and magnetic moment Measurement of the susceptibility of paramagnetic substances, Langevin's theory of diamagnetic and paramagnetic substances, Curie- Weiss Law, Theory of ferromagnetism.

UNIT III

Dielectric Properties of Solids: Polarization and Susceptibility, The local field, Dielectric Constant and Polarizability, Clausius-Mossitti Equation, Sources of Polarizability (Electronic, Ionic, Dipolar Polarizability), Classical Theory of Electronic Polarizability, Frequency Dependence of Total Polarizability.

UNIT IV

Superconductivity: Introduction and Historical Developments, Electrical Resistivity, Perfect Diamagnetism or Meissner Effect, Supercurrents and Penetration Depth, London Equations, Critical Field and Critical Temperature,

Type I and Type II Superconductors, Thermodynamical properties, Flux Quantization, The Josephson Effects and Tunnelling, Idea of the BCS Theory, High Temperature Ceramic
Superconductors.

Books Recommended:

1. Charles Kittel, Introduction to Solid State Physics, Wiley India Pvt. Ltd., 8th Edn., 2004.
2. Rita John, Solid State Physics, McGraw Hill, 2014.
3. Leonid V. Azaroff, Introduction to Solids, Tata Mc-Graw Hill, 2004.
4. N.W. Ashcroft and N.D. Mermin, Solid State Physics, Saunders College Publishing, 1976.
5. H. Ibach and H. Luth, Solid-state Physics, Springer, 2009.
6. J.P. Srivastava, Elements of Solid State Physics, Prentice-Hall of India, 2nd Edn., 2006.
7. M.A. Wahab, Solid State Physics, Narosa Publications, 2011.

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Advanced Calculus

Course Code: IMTH501CR **Total Credits: 06**
Max. Marks: 90 **Theory: 04**
Min. Marks: 36 **Prectical/Tutorial: 02**

Objectives: *This course introduces students to limit, continuity, differentiability of multivarible functions. Line integral, surface integral, Gauss divergence theorem, Stoke's theorem and Fubini's theorem are the main highlights which will be tought ito the students.*

UNIT I

Limit, continuity, partial derivatives of functions of two variables, Conditions for the equality of mixed partials, maxima and minima, differentiation of functions of two variables, directional derivatives and their relationship, implicit differentiation, chain rule.

UNIT II

Double integral, partition of a rectangle, integration over a rectangle and region, conditions for integrability, differentiation under the integral sign, Green's theorem.

UNIT III

Line integrals, evaluation of line integral, transformation of line integral into double integral, Surface integral, tripple integral, transformation of surface integral. Divergence theorem, Stokes theorem.

UNIT IV

Constrained extrema involving functions of two variables, Lagranges multipliers with examples, Fubini's theorem, Change of variables.

Books Recommended:

1. Sudhir R. Ghorpade, B.V. Limaye: A Course in Multivariable Calculus and Analysis, Springer International Edition, 2010.
2. S. Dineen, Functions of two variable, Chapman and Hall, 1995.
3. David Widder, Advanced Calculus, Prentice Hall of India.

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Number Theory and Theory of Equations

Course Code: IMTH502CR | **Total Credits: 06**
Max. Marks: 90 | **Theory: 04**
Min. Marks: 36 | **Prectical/Tutorial: 02**

Objectives: *Number theory is one of the most essential components of mathematics. The aim of this course is to make the students learn about division algorithm, gcd, lcm, fundamental theorem of arithmetic, congruences and diphantine equations. The students will also be tought about different methods for solving cubic and biquadratic equations.*

UNIT I

Divisibility in integers, division algorithm, GCD, LCM, Fundamental theorem of arithmetic, infinitude of primes, Mersenne primes, perfect and Fermat numbers.

UNIT II

Property of congruences, residue classes, complete and reduced residue system, their properties, Linear Diophantine equations, Fermat theorem, Euler theorem, Wilson theorem, Linear congruence of degree 1, Chinese remainder theorem.

UNIT III

Number theoretic functions, greatest integer functions, Euler ϕ function, the number of divisors d(n), $\tau(n)$ sum of divisors $\tau(n), \mu(n), \varphi(n)$ and their properties, similar fnctions, multiplicative functions, Mobius functions, Mobius inversion formula.

UNIT IV

General properties of equations, synthetic division, Relationship between roots and coefficients of an equation, formation of equations whose roots are function of given equation, Equations of squared differences. Symmetric functions, solution of cubic and biquardratic equations by Cardan's and Descarte's method respectively.

Books Recommended:

1. Niven and Zuckerman & H.L.Montgomery, An Introduction to Theory of Numbers, John Wiley
2. David M. Burton, Elementary Number Theory, Universal book stalls.
3. W. S. Burnside and A. W. Panton, Theory of Equations, Wentworth Press 2016.

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Probability Theory

Course Code: IMTH503DSE **Total Credits: 06**
Max. Marks: 90 **Theory: 04**
Min. Marks: 36 **Prectical/Tutorial: 02**

Objectives: *The main objective of this course of probability is to provide students with the foundations of probabilistic analysis mostly used in varied applied fields. It includes the principal concepts about probability set functions along with the properties, Conditional Probability, Bayes Theorem, Mathematical Expectation, Some Special Discrete and Continuous Probability Distributions, T, Chi and F Distributions and Central Limit Theorem.*

UNIT I

Random experiment, Classical Probability, Empirical probability, Axioms of Probability, Addition Law, Multiplicative Law, Conditional Probability, Bayes Theorem, Mathematical Expectation, Chebyshev's Inequality, Weak law of large numbers.

UNIT II

Random Variable, Cumulative distribution function, probability density function, probability density curve, joint density functions and conditional probability, marginal density function, Moment generating function, Characteristic function.

UNIT III

Discrete distributions: Bernoulli, Binomial, Poisson, Negative binomial, Geometric, Hypergeometric and Multinomial. Continuous distributions: Uniform or Rectangular, exponential, Laplace or double exponential, Normal, Beta distributions of I and II kind, Gamma, Chi-square, exponential and normal.

UNIT IV

Bivariate Normal Distribution (BVND) and its Moment Generating function (MGF), conditional distribution of BVND. Sampling Distributions; t and F .

Books Recommended:

1. V. K. Rohatgi, An Introduction to Probability and Statistics.
2. S. C. Gupta and V. K. Kapoor, Fundamental of Mathematical Statistics.
3. Hogg and Craig, An Introduction to the Mathematical Statistics.
4. Mood and Grayball, An Introduction to the Mathematical Statistics.

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Discrete Mathematics

Course Code: IMTH504DSE **Total Credits: 06**
Max. Marks: 90 **Theory: 04**
Min. Marks: 36 **Prectical/Tutorial: 02**

Objectives: *The main objectives of the course is to introduce basic essentials of graph theory and discrete mathematics. The main highlights of the course are Pigeon hole principle, Euler phi function, Zorn's lemma, Konigsberg bridge problem, Euler graphes and trees.*

UNIT I

Counting principle, counting set of pairs two way counting, stirling numbers of 2nd kind, simple recursion formula satisfied by S(n,k) and direct formula for S(n, k) for k=1,2,...,n. Pigeonhole principle and its strong form, its applications to geometry. Principle of inclusion and exclusion, its applications, de arrangements, explicit formula for dn, various identities involving dn, deriving formula for Euler phi function.

UNIT II

Recurrence relations, definition of homogeneous, non-homogeneous, linear, non linear recurrence relations, recurrence relations in counting problems, homogeneous as well as non-homogeneous, recurrence relations of 2nd degree algebraic method. Partially ordered sets, Zorn's Lemma, Peano's axiom, Well ordering principle, axiom of choice, weak and strong principles of mathematical induction.

UNIT III

Introduction to graphs, paths and cycles, operations on graphs, bipartite graphs and Konig's theorem, Euler graphs and Euler's theorem, Hamiltonian graphs and Dirac's theorem. Degree sequences.

UNIT IV

Trees and their properties, binary and spanning trees, degrees in trees, Cayley's theorem, fundamental cycles, cut vertex and cut edge in a graphs, planar graphs and Euler's formula, incidence matric, adjacency matrix of a graph.

Books Recommended:

1. Norman Biggs, Discrete Mathematics, John Wiley and sons.
2. V. Krishnamurthy, Combinations Theory And Applications, Affiliated East-West Press.
3. S. Pirzada, An Introduction to Graph Theory, Universities Press, Orient BlackSwan, Hyderabad, India, 2012.
4. Richard Brauldi , Introductory Combinations, John Wiley and Sons.
5. Discrete Mathematics, Schaum's Outlines Series.
6. Allen Tukker Applied Combinations, John Wiley and Sons.

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Complex Analysis

Course Code: IMTH601CR **Total Credits: 06**
Max. Marks: 90 **Theory: 04**
Min. Marks: 36 **Prectical/Tutorial: 02**

Objectives: *The aim of this course is to expose the students to complex numbers and complex functions, complex differentiation and contouri ntegration. C-R equations, DE- Moivre"s theorem , Cauchy's theorem and Taylor theorem are the main highlights of the course.*

UNIT I

Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications, complex functions; trigonometric, inverse – trigonometric, exponential, logrithmic, hyperbolic, inverse – hyperbolic.

UNIT II

Continuity and differentiability of complex functions, analytic function, singular point, Cauchy Riemann equations, conjugate functions, harmonic functions, Necessary condition for a function to be analytic, sufficient condition for a function to be analytic, construction of analytic function.

UNIT III

Complex Integrals: Contour, simply and multiply connected domain, complex line integral, an upper bound for contour integral, Cauchy's integral theorem, Cauchy' s Integral formula, Cauchy's Integral formula for first and higher derivatives, applications of Cauchy's Integral formula for evaluation of complex integrals, Morera's Theorem, Cauchy's Inequality.

UNIT IV

Liouville's theorem, fundamental theorem of algebra, Taylors theorem, zeros. Maximum modulus principle, minimum modulus principle, identity theorem.

Books recommended:

1. Richard A. Silverman, Introductory complex Analysis, Dover publicationinc., New York.
2. E. G. Philips, Functions of a complex variable with applications, Oliver and Boyd, NY: Interscience publication, inc.
3. L. V. Ahlfors, Complex analysis, 3rd ed., McGraw-Hill Book Company.
4. J. E. Brown and R. V. Churchill, Complex Variables and Applications, 8th edition, McGrawHill International edition-2009.
5. S. Ponnusamy, foundation of complex Analysis, Narosa publishing House.

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Metric Space

Course Code: IMTH602CR **Total Credits: 06**
Max. Marks: 90 **Theory: 04**
Min. Marks: 36 **Prectical/Tutorial: 02**

Objectives: *The main aim of this course is to expose the students to the abstract sturacture of metric spaces . During the course open sets, closed sets, compactness, completeness, Cantor intersection theorem and Baire category theorwm will be tought.*

UNIT I

Inequalities: Arithmetic and Geometric mean inequalities, Cauchy's Schwarz inequality, Holders inequality and Minkowski's inequality, Jenson's inequality with illustrative problems.
Metric space and examples, Open and closed sets, closure and interior, and their results, Cauchy and convergent sequences, complete metric space.

UNIT II

Completion of a metric spaces, construction of real numbers as the completion of rationals. R^n as a (complete) metric space under certain natural metrics, Cantor's intersection theorem and counterexamples to show when it fails to hold, Continuous functions: Definition, characterizations and examples, Baire category theorem and some of its applications, including (i) the nonexistence of a function continuous precisely at rational points (ii) Dirichlet function not expressible as a pointwise limit of continuous functions.

UNIT III

Compactness in metric spaces: Bolzano-Weierstrass property, the Lebesgue number for an open covering, sequentially compact and totally bounded metric spaces, Heine-Borel theorem, Uniform continuity and examples/counterexamples, uniform continuity of continuous maps on a compact metric space.

UNIT IV

Connectedness: definition, and examples, connected sets under continuous maps, characterization in terms of continuous maps into the discrete space N, connected subsets of $\mathbb{R}$, intermediate value theorem, Invariance domain theorem for $\mathbb{R}$, Equicontinuous families of continuous functions on a metric space with examples, Arzela-Ascoli theorem in C[a,b].

Books Recommended:

1. E. T. Copson, Metric spaces, Cambridge University Press.
2. G. F. Simon, Topology and Modern Analysis, Mc Graw Hill.
3. S. Shirali, Metric Spaces, Springer.
4. S. Lipschutz, General Topology, Schaum’s Outline, McGraw Hill.

5 Year Integrated Course in Mathematics-2021
JK Institute of Mathematical Sciences

Mathematical Modeling and Operations Research

Course Code: IMTH603DSE **Total Credits: 06**
Max. Marks: 90 **Theory: 04**
Min. Marks: 36 **Prectical/Tutorial: 02**

Objectives: *This course provides a quantitative technique or a scientific approach to the executives for making better decisions for operations under their control. It studies the Origin, Definition and Development of Operations Research, Linear Programming Problem, Different methods to obtain solution to LPP, Transportation Problem and the procedures for obtaining Basic Feasible Solution, Assignment Problem, Network Analysis by Critical Path Method (CPM) and Programme Evaluation and Review Technique (PERT).*

UNIT I

General introduction to Modeling; types of Models; concept of mathematical models; classification of mathematical models; formulation; solution and interpretation of a model; Mathematical modeling through system of ordinary differential equations, compartment models through system of ODE's, simple models in economics, medicine, simple harmonic motion, projectile motions, gravitational forces and planetary motion.

UNIT II

Mathematical models through difference equations in population dynamics, linear growth and decay models, non-linear growth models, continuous population models for single species, logistic growth model, Fibonacci's numbers and the Golden ratio, compartment models, limitations of mathematical models, Modeling through graphs.

UNIT III

Definition of Operation Research, Basics of Operation Research: Origin & Development of Operation Research, Definition and Meaning of Operation Research, Different Phases of an Operation Research Study, Scope and Limitations of Operation Research, Linear Programming problem (LPP), General LPP models, Formulation of LPP models, Graphical solutions of LPP.

UNIT IV

Convexity, Simplex and Revised Simplex algorithm, Extreme point theorems, development of simplex methods, Artificial variable technique, Big M method and Two phase method. Transportation problem and its formulation, Basic Feasible solution based on North-West Corner rule.

Books Recommended:

3. J. N. Kapur, Mathematical Modelling, New Age International Publishers.
4. J.N. Kapur.Mathematical Model in Biology and Medicines.
5. M.A. Khanday, Introduction to Modeling and Biomathematics, Dilpreet Publishers, New Delhi, 2015
6. M. R. Cullen, Linear Models in Biology, Ellis Horwood Ltd.
7. Jaffrey R. Chasnov, Mathematical Biology, Hong Kong Press.
8. Hamdy, A. Taha: Operations Research – An Introduction, Prentice Hall, 9^{th}Edition, 2010.
9. F. S. Hiller, G. J. Lieberman: Introduction to Operation Research – Concepts and Cases, Tata McGraw Hill, 2010.