FUTURE UNIVERSITY

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FUTURE UNIVERSITY, BAREILLY

(Established under the Uttar Pradesh Private Universities (Third Amendment) Act, 2024)

COURSE CURRICULUM

AND

EVALUATION SCHEME

B.Sc (PCM)

For the Students Admitted in Academic Session 2025-26

Effective From

Academic Session 2025-26

Prepared By

Board of Studies

Approved By

Academic Council
Future University, Bareilly

Published By

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Future University, Bareilly

Academic Session: 2025-26

(This Curriculum and Evaluation Scheme shall be applicable to all students admitted to the B.Sc Programme from the Academic Session 2025-26 onwards and shall remain in force until amended or revised by the Academic Council of Future University, Bareilly.)

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Board of Studies

Name of Faculty: Faculty of Science
Date: 18/10/2025

Sr. No.	Name	Designation	Signature
1	Prof. (Dr.) Yogendra Kumar Singh	Professor, Future University, Bareilly	
2	Prof. (Dr.) Vinod Verma	Professor	
3	Dr. Surya Kant Sharma	Associate Professor	
4	Prof. (Dr.) Gaurav Bhadauriya	Professor, Future University, Bareilly	
5	Mr. Sarvesh Kumar Gangwar	H.O.D., Future University, Bareilly	
6	Dr. Shalabh Saxena	Associate Professor	

Chairperson

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Board of Studies

Name of Faculty: Faculty of Science
Date: 17/10/2024

S.No.	Name	Designation	Signature
1	Prof. (Dr.) Charu Khanna	Professor, Future University, Bareilly	
2	Prof. (Dr.) Vinod Verma	Professor	
3	Dr. Surya Kant Sharma	Associate Professor	
4	Prof. (Dr.) Hemant Yadav	Professor, Future University, Bareilly	
5	Prof. (Dr.) Manish Kumar Singh	Professor, Future University, Bareilly	
6	Mr. Sarvesh Kumar Gangwar	H.O.D., Future University, Bareilly	

Chairperson

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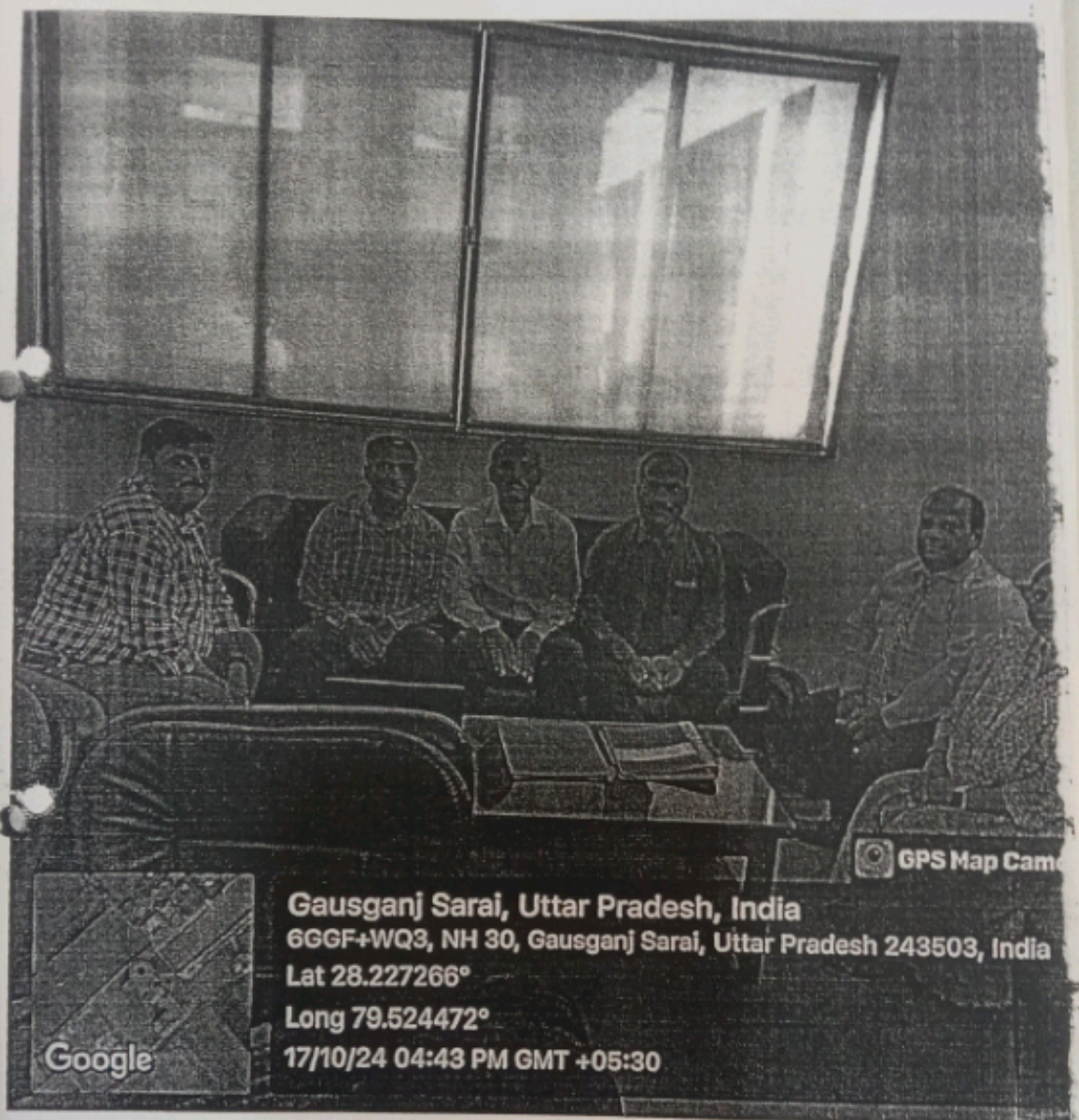

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SYLLABUS

B. Sc.

PHYSICS

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Name	Designation	Affiliation
Steering Committee		
Supervisory Committee- Science Faculty		

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SEMESTER-WISE TITLES OF THE PAPERS IN UG PHYSICS COURSE

YEAR	SEMESTER	COURSE CODE	PAPER TITLE	THEORY / PRACTICAL	CREDIT
FIRST YEAR	I		Mathematical Physics & Newtonian Mechanics	Theory	4
			Mechanical Properties of Matter	Practical	2
	II		Electromagnetic Theory	Theory	4
			Demonstrative Aspects of Electricity & Magnetism	Practical	2
SECOND YEAR	III		Physical Optics, Laser and Fiber Optics	Theory	4
			Demonstrative Aspects of Optics	Practical	2
	IV		Circuit Fundamentals and Basic Semiconductor Electronics	Theory	4
			Basic Electronics Instrumentation	Practical	2
THIRD YEAR	V		Thermodynamics and Statistical Mechanics	Theory	4
			Semiconductor Physics and Digital Electronics	Theory	4
			Thermal Properties of Matter and Digital Electronics	Practical	2
	VI		Solid State & Nuclear Physics	Theory	4
			Quantum Mechanics and Spectroscopy	Theory	4
			Project Work	Project	2

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Year: **First**	Semester: **First**
Subject: **Physics**	
Course Code:	Course Title: **Mathematical Physics & Newtonian Mechanics**

Course Outcomes (COs)

1. Recognize the difference between scalars, vectors, pseudo-scalars and pseudo-vectors.
2. Understand the physical interpretation of gradient, divergence and curl.
3. Study the origin of frames of reference and pseudo force and to study the response of the classical systems to external forces and their elastic deformation.
4. Understand the dynamics of planetary motion and the working of Global Positioning System (GPS).
5. Comprehend the different features of Simple Harmonic Motion (SHM) and wave propagation.

Unit	Topics	No. of Lectures
I	**Vector Algebra and Calculus** Scalar and vector quantities, Pseudovectors, components of vecor in 2D and 3D, unit vector, position vector and displacement vector, direction cosines and direction ratios, vector addition and subtraction, scalar and vector product, scalar triple product and vector triple product, Line integral, surface integral and volume integral, Gradient, divergence & curl and their Physical significanes, Gauss divergence theorem, stoke's theorem, Green's theorem in a plane.	7
II	**Dynamics of system of particles** Historical development of mechanics up to Newton, Newton's laws of motion and their limitations, inertial and non inertial frames, pseudo force, centre of mass and its motion, laws of conservation of linear momentum and angular momentum,work energy theorem, conservation of energy, conservative force and its properties,.	8
III	**Dynamics of a rigid body** Moment of inertia and its physical significance, theorems on moment of inertia, calculation of M. I. of rod, lamina, ring, disc, spherical shell, solid and hollow sphere and cylinder, rotational kinetic energy and radius of gyration, Rolling motion of a body on horizontal and inclined planes,Elasticity, relation among elastic constants, limiting values of Poisson's ratio, twisting of cylinder, bending of beam.	8

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IV	**Central force** Central force and its properties, reduction of two body problem to a single body problem, reduced mass, relative and centre of mass motion, Newton's law of gravitation, gravitational potential and field due to a spherical shell and solid sphere, Kepler's laws of planetary motion and their derivation, Newton's gravitational law by Kepler's law, gravitational potential energy, escape velocity, orbital speed and time of revolution of an artificial satellite, geostationary satellite, global positioning system (GPS).	7
V	**Oscillations and Waves** Simple harmonic motion, its differential equation and examples, damped harmonic motion, mean life time and relaxation time, forced harmonic motion, amplitude and velocity resonance, plane progressive wave and its displacement equation, general equation of wave motion, boundaries of linear bounded medium, phase change on reflection of a wave, stationary waves, lissajous figures	8

Suggested Readings

1. Murray Spiegel, Seymour Lipschutz, Dennis Spellman, "Schaum's Outline Series: Vector Analysis", McGraw Hill, 2017, 2e
2. D.S. Mathur, P.S. Hemne, "Mechanics", S. Chand Publishing, 1981, 3e
3. J.C. Upadhyaya, "Mechanics", Ram Prasad publications.

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Year: **First**	Semester: **First**
Subject: **Physics**	
Course Code:	Course Title: **Mechanical Properties of Matter**

Course Outcomes (COs)

Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the mechanical properties. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Topics

Lab Experiment List

1. Use of Vernier calipers and screw gauge to determine thickness and diameter
2. Modulus of rigidity by Maxwell's needle
3. Verification of theorem of parallel axes by Maxwell needle
4. Acceleration due to gravity by bar pendulum
5. Young's modulus by bending of beam

Suggested Readings

1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e
2. R.K. Agrawal, G. Jain, R. Sharma, "Practical Physics", Krishna Prakashan Media (Pvt.) Ltd., Meerut, 2019
3. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014, 2e

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Year: **First**	Semester: **Second**
Subject: **Physics**	
Course Code:	Course Title: **Electromagnetic Theory**

Course Outcomes (COs)

1. Better understanding of electrical and magnetic phenomenon in daily life.
2. To troubleshoot simple problems related to electrical devices.
3. Comprehend the powerful applications of ballistic galvanometer.
4. Understandings of Maxwell's equations in various vacuum and other media.
5. Elementary study of electromagnetic waves.

Unit	Topics	No. of Lectures
I	**Unit 1 : Electrostatics** Charge densities, Coulomb's law, Electric Field and Electric Potential, Gauss' law and its applications (point charge, line charge, sheet, conducting and non conducting solid sphere, cylinder), Differential form of Gauss' law, Curl of electric field, Poisson's and Laplace equation, Electric potential and field due to short electric dipole and quadrupole, Dielectric constant, Electric susceptibility, Dielectric Polarization, Gauss' law in presence of dielectric (integral and differential form)	7
II	**Unit 2 : Magnetostatics** Biot-Savart's law and its applications (long straight current carrying conductor, circular loop), Ampere's circuital law and its applications (long straight current carrying conductor and long solenoid), Magnetic scalar and vector potential, Magnetic properties of materials, Magnetic susceptibility and Permeability, Dia, Para and Ferromagnetic materials, B-H curve.	8
III	**Unit 3 : Electromagnetic induction** Faraday's laws of electromagnetic induction, Self and mutual induction, self inductance of a solenoid, Energy stored in magnetic field of a solenoid, reciprocity theorem of mutual inductances, coupling of two coils with flux linkage, Betatron, Moving coil Ballistic galvanometer	8

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IV	**Unit 4 : Maxwell's equations** Equation of continuity, Displacement current, Maxwell's equations (Differential and Integral forms with physical significance), Maxwell's equations in free space , Maxwell's equations in linear isotropic medium.	7
V	**Unit 4 : Electromagnetic waves** EM wave equations in vacuum, Solution of EM wave equation, Plane EM waves, Characteristics of plane EM waves in vacuum (with proof), relation between electric and magnetic fields of an electromagnetic wave, Poynting vector and Energy density.	8

Suggested Readings

1. D.J. Griffiths, "Introduction to Electrodynamics", Prentice-Hall of India Private Limited, 2002, 3e
2. E.M. Purcell, "Electricity and Magnetism (In SI Units): Berkeley Physics Course Vol 2", McGraw Hill, 2017,2e
3. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 2",
4. Pearson Education Limited, 2012 D.C. Tayal, "Electricity and Magnetism", Himalaya Publishing House Pvt. Ltd., 2019, 4e

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Year: **First**	Semester: **Second**
Subject: **Physics**	
Course Code:	Course Title: **Demonstrative Aspects of Electricity and Magnetism**

Course Outcomes (COs)

Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the mechanical properties. Measurement precision and perfection is achieved through Lab Experiments.

Topics

Lab Experiment List

1. Variation of magnetic field along the axis of a coil
2. Ballistic Galvanometer: Ballistic constant
3. Ballistic Galvanometer: High resistance by Leakage method
4. Carey Foster.s Bridge: Resistance per unit length and specific resistance
5. Calibration of voltmeter by a potentiometer.

Suggested Readings

1. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1e
2. R.K. Agrawal, G. Jain, R. Sharma, "Practical Physics", Krishna Prakashan Media (Pvt.) Ltd., Meerut, 2019
3. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014, 2e

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Year: **Second**	Semester: **Third**
Subject: **Physics**	
Course Code:	Course Title: **Physical Optics, Laser and Fiber Optics**

Course Outcomes (COs)

1. Study of coherence and interference of light.
2. Study of Fresnel and Fraunhoffer diffraction.
3. Comprehend the use of polarimeters.
4. Study the characteristics and uses of lasers.
5. Basic study of fiber optics

Unit	Topics	No. of Lectures
I	**Interference** Spatial and Temporal coherence, Theory of interference, Division of wavefront- Two slit arrangement and Fresnel's Biprism, Displacement of fringes by introduction of a thin plate, Division of amplitude- Interference in Thin film and wedge shaped film, Theory of Newton's rings, Michelson's interferometer- working, form of fringes and applications	8
II	**Diffraction** Fresnel's half period zones, Resultant amplitude due to Wavefront, Zone plate- construction, theory and multiple foci of Zone plate, Fraunhofer's diffraction at single slit and double slit, Plane transmission diffraction Grating, Resolving power of an optical instrument, Rayleigh's criterion, Resolving power of Grating, telescope and microscope.	9
III	**Polarization** Polarization, Brewster's law, Plane of vibration and Plane of polarization, Double refraction in uniaxial crystals, Nicol prism, Polaroids, Phase retarding Plates, Fresnel's theory of Optical rotation, Specific rotation, half shade and biquartz polarimeters, Babinet,s Compensator, Analysis of plane polarized, circularly and elliptically polarized lights	8

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IV	**Laser** Absorption, Spontaneous and Stimulated Emissions, Einstein's A and B Coefficients, Population inversion, Optical pumping, Ruby Laser (A pulsed laser), He-Ne Laser (Gas Laser), Properties and uses of Laser.	7
V	**Basics of Fiber Optics** Basics of Fiber optics, Step index and Graded index fiber, Multimode fiber (MMF) and Single mode Fiber (SMF), Propagation through fiber, Acceptance angle and Numerical Aperture, Fiber losses, Attenuation, Applications of optical fiber	6

Suggested Readings

1. Francis A. Jenkins, Harvey E. White, "Fundamentals of Optics", McGraw Hill, 2017, 4e
2. Samuel Tolansky, "An Introduction to Interferometry", John Wiley & Sons Inc., 1973, 2e
3. N. Subrahmanyam, Brij Lal, M.N.Avadhanulu, "A text book of Optics", S. Chand
4. A. K. Ghatak, "Optics", McGraw Hill, 2017, 6e

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Year: **Second**	Semester: **Third**
Subject: **Physics**	
Course Code:	Course Title: **Demonstrative aspects of Optics**

Course Outcomes (COs)

Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the mechanical properties. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Topics

Lab Experiment List

1. To determine focal length of lens combination.
2. To determine wavelength of sodium light by Newton's ring's.
3. To determine refractive index of prism by spectrometer.
4. To study spectrum of plane transmission grating.
5. To verify inverse square law.

Suggested Readings

1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e
2. R.K. Agrawal, G. Jain, R. Sharma, "Practical Physics", Krishna Prakashan Media (Pvt.) Ltd., Meerut, 2019
3. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014, 2e

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Year: **Second**	Semester: ***Fourth***
Subject: **Physics**	
Course Code:	Course Title: **Circuit fundamentals and Basic Semiconductor Electronics**

Course Outcomes (COs)

1. Understanding D. C. circuits and Network theorems, Utility of AC bridges.
2. Study of semiconductors and power supply
3. Understing the working and characteristics of transistors
4. Study of amplifiers
5. Study of feedback in amplifiers and oscillators.

Unit	Topics	No. of Lectures
I	**Circuit Fundamentals** Growth and decay of current in LR circuit, charging and discharging of capacitor in CR and LCR circuits, A.C. bridges- Anderson bridge, Maxwell's bridge, Wien's bridge, Schering bridge. Network theorems – superposition, Thevenin's and Norton's theorems.	9
II	**Semiconductors and Power supply** Distinction between conductors, semiconductors and insulators, Intrinsic and Extrinsic semiconductors, Fabrication of PN junction, PN junction diode, forward and reverse biasing, characteristics, half and full wave rectifiers with mathematical analysis, Filter circuits, Breakdown mechanism, Zener diode, characteristics, Zener diode as voltage regulator.	9
III	**Bipolar junction Transistor** BJT, working of PNP and NPN transistors, Transistor connections, CB, CE mode characteristics, constants of a transistor α and β, transistor leakage currents, Transistor biasing, Stability factor, methods of transistor biasing, D.C. load line	8

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IV	**Amplifiers** Two port representation of a transistor, Z, Y and h parameters, hybrid equivalent circuit of transistor, CE and CB transistor amplifiers (mathematical analysis using hybrid parameters), RC coupled amplifier, Transformer coupled amplifier, basic idea about power amplifiers and their classification	7
V	**Feedback and Oscillators** Feedback in amplifiers, basic principles of feedback, advantages of negative feedback, Oscillator, essentials of an oscillator, principles of oscillations, Barkhausen criterion for oscillations, Tuned collector oscillator, Hartley oscillator, Colpitt's oscillator, Phase shift oscillator, Wein bridge oscillator.	7

Suggested Readings

1. J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
2. Sudhakar, S.S. Palli, "Circuits and Networks: Analysis and Synthesis", McGraw Hill, 2015, 5e
3. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e.
   V. K. Mehta, Principles of Electronics, S. Chand Publication.

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Year: **Second**	Semester: **Fourth**
Subject: **Physics**	
Course Code:	**Course Title: Basic Electronics Instrumentation**

Course Outcomes (COs)

Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the mechanical properties. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Topics

Lab Experiment List

1. To determine the self inductance by Anderson's bridge.
2. To study of characteristics of PN junction diode.
3. To study the characteristics of zener diode.
4. To study of characteristics of PNP/NPN transistor.
5. To study frequency response of RC coupled amplifier.

Suggested Readings

1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e
2. R.K. Agrawal, G. Jain, R. Sharma, "Practical Physics", Krishna Prakashan Media (Pvt.) Ltd., Meerut, 2019
3. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014, 2e

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Year: **Third**	Semester: **Fifth**
Subject: **Physics**	
Course Code:	Course Title: **Paper I (Thermodynamics and Statistical Mechanics)**

Course Outcomes (COs)

1. Recognise laws of thermodynamics and heat engine
2. Understand the physical significance of entropy and thermodynamical potentials
3. Recognize the difference between macrostate and microstate.
4. Comprehend the concept of ensembles.
5. Understand the classical and quantum statistical distribution laws.

Unit	Topics	No. of Lectures
I	**Laws of thermodynamics and Carnot Engine** Open, closed and isolated systems, thermodynamic equilibrium, internal energy, work, zeroth law and first law of thermodynamics, thermodynamic processes, work done in isothermal, adiabatic, isobaric and isochoric processes, Indicator diagram, Heat engine and efficiency, Carnot engine, its working and efficiency, Second law of thermodynamics, Carnot theorem,	9
II	**Entropy and Maxwell's Relations** Entropy and its physicsl significance, change of entropy in reversible and irreversible processes, change of entropy of an ideal gas, change of entropy for phase change and temperature change of substance. T-S diagram, Entropy and Second law, Principle of increase of entropy. Thermodynamic potentials and Maxwell's relations, Applications of Maxwell's relations (Clasius Clapeyron equation, Joule Thomson coefficient)	9
III	**3 Microstate, Macrostate and concept of Ensemble** Probability, tossing of coins, distribution of particles between two halves of a box, microstates and macrostates, postulate of equal a priori probability, Phase space, counting of number of microstates, equilibrium between two systems in thermal contact and beta parameter. Entropy and Probability, Ensembles and Ensemble average.	8

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IV	**Classical Statistical Mechanics** Classification of Statistical mechanics, Maxwell Boltzmann distribution law, Maxwell's velocity distribution law and speed distribution law, Expressions for average speed, rms speed and most probable speed, degrees of freedom, Law of Equipartition of Energy and its application for specific heats of a gas, Partition fuction. Relation between partition function and thermodynamic potentials.	7
V	**Quantum Statistical Mechanics** Fermi Dirac distribution law, Application of Fermi Dirac distribution law on free electrons in metal, Calculation for Fermi energy, Average free electron energy at absolute zero, Bose Einstein distribution law, Its application on Black body radiation, Planck's radiation law	7

Suggested Readings

1. M.W. Zemansky, R. Dittman, "Heat and Thermodynamics", McGraw Hill, 1997, 7e
2. F.W. Sears, G.L. Salinger, "Thermodynamics, Kinetic theory & Statistical thermodynamics", Narosa Publishing House, 1998
3. S. Garg, R. Bansal, C. Ghosh, "Thermal Physics", McGraw Hill, 2012, 2e
4. Brij Lal, N. Subrahmanyam, P.S. Hemne, "Heat, Thermodynamics and Statistical Physics", S. Chand & company
5. F. Reif, "Statistical Physics (In SI Units): Berkeley Physics Course Vol 5", McGraw Hill, 2017, 1e
6. B.B. Laud, "Fundamentals of Statistical Mechanics", New Age International Private Limited, 2020, 2e
7. B.K. Agarwal, M. Eisner, "Statistical Mechanics", New Age International Private Limited, 2007, 2e

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Year: **Third**	Semester: **Fifth**
Subject: **Physics**	
Course Code:	Course Title: **Paper 2 (Semiconductor Physics and Digital Electronics)**

Course Outcomes (COs)

1. Study the working, properties and uses of FETs.
2. Comprehend the design and operations of SCRs and UJTs.
3. Understand various number systems and binary codes.and familiarize with binary arithmetic.
4. Study the working and properties of various logic gates.
5. Comprehend the design of combinational and sequential circuits.

Unit	Topics	No. of Lectures
I	**Field Effect Transistors** FET classification, Construction of n-channel and p-channel JFET, Operation and Characteristics of n-channel JFET, Drain current equation, JFET biasing, Common source FET amplifier, Advantages of FET over BJT, Depletion and enhancement type MOSFETs, Construction, Operation and Characteristics of Depletion and Enhancement MOSFETs, FET Parameters, Advantages of MOSFET over JFET.	9
II	**SCR and UJT** SCR: Construction; Equivalent Circuit using Two Transistors; Working (Off state & On state); Characteristics; Applications of SCR. UJT: Construction, Equivalent Circuit, Working (Cutoff, Negative Resistance & Saturation regions); Characteristics, Applications of UJT.	9
III	**Number Systems, Binary arithmetic and Boolean Algebra** Number Systems: Decimal, Binary, Octal & Hexadecimal number systems and their inter conversion. Binary Codes: BCD, Excess-3 (XS3), Parity, Gray, ASCII & EBCDIC Codes and their advantages & disadvantages, Binary Addition, Binary Subtraction using 1's & 2's compliment, Binary Multiplication, Boolean algebra.	8

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IV	**Logic Gates** Truth tables and symbols OR, AND, NOT, NOR, NAND, EX-OR & EX-NOR Gates. Realization using diodes & transistors and key diagrams of OR, AND and NOT gates. NOR & NAND gates as Universal Gates.	7
V	**Combinational Logic Circuits** Combinational Circuits: Half Adder, Full Adder, Parallel Adder, Half Substractor, Full Substractor. Data Processing Circuits: Multiplexer, Demultiplexer, Decoders & Encoders	7

Suggested Readings

1. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
2. J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
3. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
4. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
5. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e
6. D. Leach, A. Malvino, Goutam Saha, "Digital Principles and Applications", McGraw Hill, 2010, 7e
7. William H. Gothmann, "Digital Electronics: An Introduction to Theory and Practice", Prentice-Hall of India Private Limited, 1982, 2e
8. R.P. Jain, "Modern Digital Electronics", McGraw Hill, 2009, 4e
9. V.K. Mehta, "Principles of Electronics", S. Chand & company

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Year: **Third**	Semester: **Fifth**
Subject: **Physics**	
Course Code:	Course Title: **Thermal properties of matter and digital electronics**

Course Outcomes (COs)

Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the mechanical properties. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Topics

Lab Experiment List

1. Coefficient of thermal conductivity of copper by Searle's apparatus
2. Verification of Stefan's law
3. Field effect transistor characteristics
4. Verification of truth tables of logic gates
5. Adder and subtractor circuits

Suggested Readings

1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e
2. R.K. Agrawal, G. Jain, R. Sharma, "Practical Physics", Krishna Prakashan Media (Pvt.) Ltd., Meerut, 2019
3. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014, 2e

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Year: **Third**	Semester: **Sixth**
Subject: **Physics**	
Course Code:	Course Title: **Paper 1 (Solid State and Nuclear Physics)**

Course Outcomes (COs)

1. Understand the structure of various types of crystals.
2. Comprehend the power of X-ray diffraction and the concept of reciprocal lattice.
3. Study various properties based on crystal bindings.
4. Study the salient features of nuclear forces, nuclear models & radioactive decays.
5. Comprehend the working and applications of nuclear accelerators and detectors.

Unit	Topics	No. of Lectures
I	**Elements of Crystal Structure** Crystal lattice, translational vectors, unit cell, basis, 2 and 3 dimensional bravais lattices, coordination number, lattice constant, crystal planes and miller indices, interplanar spacing,NaCl, CsCl, packing of hcp, fcc, bcc and simple cubic structures, packing fraction, diamond structure	8
II	**X rays diffraction and Reciprocal lattice** Bragg's equation, Reciprocal lattice, Geometrical interpretation of Bragg's condition, Brillouin zones, atomic scattering factor, Geometrical structure factor, reciprocal lattice to simple cubic, bcc, fcc and hcp structures, Experimental determination of crystal structure, Laue method, Rotating crystal method, Powder method.	9
III	**Crystal types and Crystal bindings** Ionic crystals, covalent crystals, metallic crystals, molecular crystals, hydrogen bonded crystals, Inert gas crystals, calculation of binding energies, Madelung constant and its calculation.	6

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IV	**General properties of nucleus and nuclear models** General Properties of Nucleus: Mass, binding energy, radii, angular momentum, Nuclear Forces: General characteristic of nuclear force and Yukawa's meson theory Radioactive Decay, fundamental laws of radioactive disintegration and radioactive series Nuclear Models: Liquid drop model and Bethe-Weizsacker mass formula. Single particle shell model	9
V	**Accelerators, detectors and classification of elementary particles** Theory of nuclear fission (qualitative), Nuclear reactors and Nuclear fusion. Accelerators: Theory, working and applications of Cyclotron and Synchrotron. Detectors: Theory, working and applications of Bubble chamber, GM counter, Scintillation counter and Wilson cloud chamber. Classification of elementary particles	8

Suggested Readings

1. Kenneth S. Krane, "Introductory Nuclear Physics", Wiley India Private Limited, 2008
2. Bernard L. Cohen, "Concepts of Nuclear Physics", McGraw Hill, 2017
3. S.N. Ghoshal, "Nuclear Physics", S. Chand Publishing, 2019
4. Charles Kittel, "Introduction to Solid State Physics", Wiley India Private Limited, 2012, 8e
5. A.J. Dekker, "Solid State Physics", Macmillan India Limited, 1993
6. R.K. Puri, V.K. Babbar, "Solid State Physics", S. Chand Publishing, 2015
7. J.P. Srivastava, "Elements of Solid State Physics", Prentice Hall of India
8. B.S. Saxena, R.C. Gupta, P.N. Saxena, J.N. Mandal, fundamentals of Solid State Physics, Pragati Prakashan
9. V.K. Mittal, R.C. Verma, S.C. Gupta, " Introduction to Nuclear and Particle Physics", PHI learning
10. R. Prasad, "Nuclear Physics", Pearson Education India

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Year: **Third**	Semester: **Sixth**
Subject: **Physics**	
Course Code:	Course Title: **Paper 2 (Quantum Mechanics and Spectroscopy)**

Course Outcomes (COs)

1. Understand the Quantum theory of radiation and its consequences.
2. Understand wave particle duality and uncertainty principle.
3. Develop the technique of solving Schrodinger equation for 1D problems.
4. Comprehend the success of Vector atomic model in the theory of Atomic spectra.
5. Study the different aspects of spectra of Group I & II elements.

Unit	Topics	No. of Lectures
I	**Origin of Quantum Mechanics** Properties of thermal radiation, Distribution of energy in the spectrum of black body radiation, Wein's displacement law, Wein's distribution law, Rayleigh Jeans law, Quantum theory of radiation, Planck's radiation law, Photo electric effect, Compton effect.	8
II	**Wave Particle Duality and Uncertainty Principle** de Broglie hypothesis, Davission and Germer experiment, concept of Wave packet, Group velocity and phase velocity, Heisenberg's uncertainty principle, theoretical and experimental proof, applications of uncertainty principle.	7
III	**Schroedinger Wave Equation and its Applications** Time independent and time dependent Schroedinger wave equation, Physical swsignificance of wave function, conditions of normalization and orthogonality, probability current density, Particle in one dimensional box, one dimensional potential step, rectangular potential barrier, square well potential, one dimensional simple harmnonic oscillator.	9

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IV	**Vector Atom model** Inadequacies of Bohr's model, Sommerfeld's relativistic correction in Bohr's theory and fine structure of H-alpha line. Deuteron spectrum, Vector model of atom, Stern-Gerlach experiment , quantum numbers, LS & jj couplings, spectroscopic notation for energy states, selection rules for transition of electrons and intensity rules for spectral lines.	9
V	**Alkali and alkaline elements spectra** Spectra of alkali elements, principal, sharp, diffuse & fundamental series; doublet structure of spectra and fine structure of Sodium D line, Spectra of alkaline elements: Singlet and triplet structure of spectra.	7

Suggested Readings

1. D.J. Griffiths, "Introduction to Quantum Mechanics", Pearson Education, India, 2004, 2e
2. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 3"
3. R Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e
4. H.E. White, "Introduction to Atomic Spectra", McGraw Hill, 1934
5. R Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e
6. S.L. Gupta, V. Kumar, R.C. Sharma, "Elements of Spectroscopy", Pragati Prakashan, Meerut, 2015, 27e
7. Rajkumar, "Atomic and Molecular Physics", Campus books international

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Future University

Syllabus

For

B.Sc.

MATHEMATICS

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Course Objective:

The B.Sc. **(Mathematics)** program equips students with specialized skills to identify and solve critical problems across diverse application areas, primarily through a deep understanding of Mathematics and its interdisciplinary connections. The program fosters the ability to apply mathematical principles and related sciences to gain a comprehensive understanding of core knowledge in various fields of Mathematical Sciences. It aims to help students appreciate the role of Mathematics in enhancing the quality of life and encourages them to recognize and value the contributions of great scientists in Mathematics and related fields.

Program Outcomes (POs):

Mathematical Knowledge: Develop a strong foundation in core mathematical concepts and techniques, enabling graduates to understand and solve complex problems across various mathematical disciplines.

Problem-Solving Skills: Enhance logical reasoning and analytical thinking abilities to apply mathematical methods in real-world problem-solving in fields like science, engineering, economics, and industry.

Critical and Analytical Thinking: Cultivate the ability to analyze, interpret, and evaluate quantitative data critically to make informed decisions and propose mathematical solutions.

Application of Mathematical Tools: Gain proficiency in using mathematical tools, software, and technologies for modeling, simulation, and computation in diverse applications.

Interdisciplinary Knowledge: Integrate mathematical knowledge with other disciplines, enabling the use of mathematics in interdisciplinary contexts, such as data science, finance, and technology.

Research Aptitude: Develop research skills to approach mathematical problems creatively, think abstractly, and contribute to advancements in mathematical research.

Communication and Presentation Skills: Build the capacity to effectively communicate mathematical ideas, theories, and solutions in both written and oral forms to a broad audience.

Ethical and Professional Responsibilities: Understand and practice ethical behavior and professional responsibilities in the application of mathematical knowledge to address societal and global challenges.

Teamwork and Leadership: Learn to work collaboratively within multidisciplinary teams, providing leadership and contributing constructively to achieving shared goals.

Preparation for Further Studies: Equip graduates with the skills and knowledge to pursue advanced studies and research in mathematics or related fields at the postgraduate level.

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SUBJECT: MATHEMATICS

Name	Designation	Affiliation
Steering Committee		
Supervisory Committee-Science Faculty		

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SEMESTER WISE TITLES OF THE PAPER IN UG MATHEMATICS COURSE

SEMESTER	COURSE CODE	PAPER TITLE	THEORY/PRACTICAL	CREDIT
I		Differential Calculus & Trigonometry	THEORY	4
II		Sequence & Series and Integral Calculus	THEORY	4
III		Algebra & Real Analysis	THEORY	4
IV		Differential Equation & Modern Algebra	THEORY	4
V		Matrix & Linear Algebra	THEORY	4
		Any One of The Following	THEORY	4
		(i) Operation Research		
		(ii) Graph Theory & Discrete Mathematics		
VI		Complex Analysis	THEORY	4
		Any one of the Following: 1. Numerical Analysis 2. Differential Geometry	THEORY	4

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PROPOSED STRUCTURE OF UG MATHEMATICS SYLLABUS AS PER NEP 2020 GUIDELINES GENERAL OVERVIEW

B.Sc. I Year

PROGRAMME	SEMESTER	PAPER	CREDIT	PERIODS	PERIODS (HOURS)	PAPER TITLE	UNIT	Periods	PREREQUISITE	ELECTIVE
	(15 Weeks)			Per Week	Per Semester			Per Semester		(For Other Faculty)
									Mathematics 12th	

Details Syllabus Mathematics:

B.A./B.Sc. I (SEMESTER-I) PAPER-I Differential Calculus & Trigonometry

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Programme:Class: B.Sc.	Year: First	Semester: First

Subject: Mathematics

Course Code:	Course Title: Differential Calculus & Trigonometry

Course outcomes:Upon successful completion of this course, students will be able to:

1. Understand Fundamental Concepts of Limits and Continuity Students will develop a strong foundation in understanding the concepts of limits and continuity, which are the building blocks for differential calculus.
2. Apply Derivatives to Solve Real-World Problems Students will be able to differentiate algebraic, trigonometric, and exponential functions, applying derivatives to solve practical problems related to rates of change, optimization, and motion analysis.
3. Explore Geometrical Interpretations Using Derivatives Students will gain the ability to interpret geometrical ideas like tangents and normals to curves, as well as apply calculus to analyze curve behavior and slope functions.
4. Master the Techniques of Differentiation: Students will become proficient in various differentiation techniques, including the product rule, quotient rule, chain rule, and implicit differentiation, enhancing their ability to handle complex problems.
5. Understand the Fundamental Concepts of Trigonometric Functions :Students will gain a solid understanding of trigonometric functions, identities, and their properties, allowing them to apply these concepts in both pure and applied mathematics.
6. Apply Trigonometric Identities and Formulas in Problem-Solving :Students will be skilled at using key trigonometric identities, such as Pythagorean identities, sum and difference formulas, and double- and half-angle formulas, in simplifying and solving complex mathematical problems.
7. Connect Calculus and Trigonometry to Real-Life Applications :Students will explore how differential calculus and trigonometric functions are applied in areas such as physics, engineering, biology, and economics, particularly in modeling periodic phenomena and optimization problems.

(Differential Calculus & Trigonometry)

Unit	Topic	No of Lectures
I	Limit, continuity of function of single variable,Cauchy's definition, Heine's definition, Uniform continuity, Borel's theorem, boundedness theorem, Bolzano's theorem, indeterminate forms.	8
II	Differentiability of function of single variable,Rolle's theorem, Lagrange and Cauchy Mean value theorems, mean value theorems of higher order, Taylor's theorem with various forms of remainders, Successive differentiation, Leibnitz theorem, Maclaurin's and Taylor's series.	9
III	Partial differentiation, Euler's theorem on homogeneous function,Tangent and normals, Asymptotes (Cartesian form only) Curvature,Radius of curvature center of curvature, Chord of curvature, Envelops (one & Two Parameters) and evolutes	
IV	Complex Number (Polar form) and De-Moivre's Theorem, Exponetial Value of sine and cosine , Circular & Hyperbolic Function.	8
V	Inverse Circular and Inverse Hyperbolic Functions, Logarithms of Complex Quantities	7

Suggested Readings:

1. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, 2005.

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Programme:Class: B.Sc.	Year: First	Semester: Second
Subject: Mathematics		
Course Code:	Course Title: Sequence & Series and Integral Calculus	

Course outcomes: Upon successful completion of this course, students will be able to:

1.Understand the Convergence and Divergence of Series: Students will be able to determine the convergence or divergence of a given series using standard tests such as the comparison test, ratio test, root test, and integral test.

2. Mastery of Sequences: Students will develop a deep understanding of the behavior of sequences, including monotonic, bounded, and Cauchy sequences, and the concepts of limit superior and limit inferior. Students will be able to apply their knowledge of sequences and series to solve problems in fields like differential equations, etc.

4.Mastery in Techniques of Integration: Students will demonstrate proficiency in various integration techniques, including substitution, integration by parts, partial fractions, and trigonometric substitutions, and will apply these techniques to solve complex integrals.

5.Applications of Definite Integral: Students will apply definite integrals to solve real-world problems involving areas under curves, volumes of solids of revolution, arc lengths, surface areas, and work.

6.Improper Integrals and Their Convergence: Students will learn to evaluate improper integrals and determine their convergence using appropriate tests like the comparison test, limit comparison test, and integral test.

7.Multivariable Integral Calculus: Students will gain an understanding of double and triple integrals, as well as surface and volume integrals, and their applications in areas such as physics, engineering, and geometry.

Sequence & Series and Integral Calculus

Unit	Topic	No of Lectures
I	Definition of a sequence, theorems on limits of sequences, bounded and monotonic sequences, Cauchy's convergence criterion, Cauchysequence, limit superior and limit inferior of a sequence, subsequence, Series of non-negative terms, convergence and divergence, Comparison tests, Cauchy's integral test, Ratio tests, Root test, Raabe's logarithmic test, de Morgan and Bertrand's tests, alternating series, Leibnitz's theorem, absolute and conditional convergence	9
II	Definite integrals and as limit of the sum, , Beta and Gamma functions, Improper integrals, their classification and convergence, Comparison test, μ-test, Abel's test, Dirichlet's Test, Quotient test.	8
III	Riemann integral, Inerrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus.	8
IV	Multiple integrals, change of order of double integration, Dirichlet's theorem, Liouville's theorem for multiple integrals.	7
V	Rectification, Volumes and Surfaces of Solid of revolution, Differentiation under the sign of Integration.	7

2. Course Books published in Hindi may be prescribed by the Universities.
3. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2007.
4. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc., 2002.
5. S. Balachandra Rao & C. K. Shantha, Differential Calculus, New Age Publication.

Suggested Books:

1. T.M. Apostal, Calculus Vol. II, John Wiley Publication
2. Shanti Narayan & Dr. P.K. Mittal, Integral Calculus, S.Chand
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons,
4. H. K Das Engineering Mathematics S. Chand.
5. R.G. Bartle & D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons
6. 7. Course Books published in Hindi may be prescribed by the Universities

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Programme:Class: B.Sc.	Year: Second	Semester: Third
Subject: Mathematics		
Course Code:	**Course Title:** Algebra & Real Analysis	

1. Set relation and Group is one of the building blocks of modern algebra. Objective of this course is to introduce students to basic concepts of Group. theory and their properties.
2. The course is aimed at exposing the students to foundations of analysis which will be useful in understanding various physical phenomena and gives the student the foundation in mathematics.
3. Basic metric space is use to develop students knowledge to understand sequences as well as distance function.
4. The aim to Two variable limit is to develop growth to define function on a surface and make geometry accordingly.

(Algebra and Real Analysis)

Unit	Topic	No of Lectures
I	Set, relations and partitions, Congruence modulo m, Group with examples and simple properties, Subgroups, Generators of a group, Cyclic groups. Homomorphism, Isomorphism ,Fundamental theorem of isomorphism.	9
II	Permutation groups, Even and odd permutations, The alternating group, Cayley's theorem, Direct products, Coset decomposition, Lagrange's theorem and its consequences, Fermat and Euler theorems	8
III	Limit and Continuity of functions of two variables, Differentiation of function of two variables, Necessary and sufficient condition for differentiability of functions two variables, Schwarz's and Young theorem,	8
IV	Taylor's theorem for functions of two variables with examples, Maxima and minima for functions of two variables, Lagrange multiplier method, Jacobians.	8
V	Metric spaces: Definition and examples, Sequences in metric spaces, Cauchy sequences, Complete metric space	7

Suggested Readings:

1. J.B. Fraleigh, A first course in Abstract Algebra, Addison-weley
2. I. N. Herstein, Topics in Algebra, John Wiley & Sons
3. G.F. Simmons, Differential Equations with Application and Historical Notes, Tata –McGrawHill
4. Mathematical Analysis by Shanti Narain.
5. Shirali, Satish & Vasudeva, H. L. (2009). Metric Spaces, Springer, First Indian Print.
6. Kumaresan, S. (2014). Topology of Metric Spaces (2nd ed.). Narosa Publishing House. New Delhi
7. Course Books published in Hindi may be prescribed by the Universities

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Programme:Class: B.Sc.	Year: Second	Semester: Fourth
Subject: Mathematics		
Course Code:	Course Title: Differential Equation & Modern Algebra	

1. The subjects of the course are designed in such a way that they focus on developing mathematical skills in algebra, calculus and analysis and give in depth knowledge of geometry, calculus, algebra and other theories.
2. The course in differential equation intends to develop problem solving skills for solving various types of differential equation and geometrical meaning of differential equation.
3. Students will be able to know the concepts of group, ring and other related properties which will prepare the students to take up further applications in the relevant fields.

Differential Equation & Modern Algebra

Unit	Topic	No of Lectures
I	Formation of differential equations, Geometrical meaning of a differential equation, Solution of equations by variable separations, Equation of first order and first degree ,Homogeneous equations, Exact differential equations and equations reducible to the exact form, Linear equations.	9
II	Second order linear differential equations with variable coefficients: Use of a known solution to find another, normal form, method of undetermined coefficient, variation of parameters,	8
III	Higher order differential equation with constant coefficient, with particular integrals, Homogeneous linear differential equations with constant coefficient.	8
IV	Automorphism, inner automorphism, Automorphism groups, Automorphism groups of finite and infinite cyclic groups, Characteristic subgroups, Commutator subgroup and its properties; Applications of factor groups to automorphism groups.	8
V	Rings, Subrings, Integral domains and fields, Characteristic of a ring, Ideal and quotient rings, Ring homomorphism, Field of quotient of an integral domain. Polynomial rings over commutative rings, Division algorithm and consequences, Principal ideal domains, Factorization of polynomials, Reducibility tests, Irreducibility tests, Eisenstein criterion, Unique factorization in $Z[x]$.	7

Suggested Readings:

1. G.F. Simmons, Differential Equations with Application and Historical Notes, Tata –McGrawHill
2. B. Rai, D.P. Choudhary & H. J. Freedman, A Course of Ordinary Differential Equations, Narosa Press of the Pacific.
3. Suggested digital plateform:NPTEL/SWAYAM/MOOCs
4. Topics in Algebra by I. N. Herstein.
5. Course Books published in Hindi may be prescribed by the Universities

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Programme:Class: B.Sc.	Year: Third	Semester: Fifth
Subject: Mathematics		
Course Code:	Course Title: Linear Algebra and Matrix	

1. Linear algebra is a basic course in almost all branches of science. The objective of this course is to introduce a student to the basics of linear algebra andsome of its applications.
2. Vector space, independency of vectors is important to make relation in geometry.
3. Knowledge of Linear transformation, IPS , matrix representation help to programming in computers and real life connectivity.
4. Matrix is useful to many of geometrical and multivariable solutions of linear equations.
5. The knowledge of rank , Eigen values ,Eigen Vectors are use to students for connectivity of Machines and many real life applications.

Linear Algebra and Matrix

Unit	Topic	No of Lectures
I	Vector spaces, Subspaces, Linear combination, Span, Linear and direct sums, Linear independence and dependence of vectors, Basis and Dimension, Quotient space.	9
II	Linear transformations, The Algebra of linear transformations, rank nullity theorem, their representation as matrices. Linear functional, Dual space	8
III	Inner product spaces and norms, Cauchy-Schwarz inequality, Orthogonal vectors, Orthonormal sets and bases. Bessel's inequality	8
IV	Types of Matrices, Elementary operations on Matrices, Rank of a Matrix, Echelon form of a Matrix, Normal form of a Matrix, Inverse of a Matrix by elementary operations, System of linear homogeneous and non-homogeneous equations, Theorems on consistency of a system of linear equations.	8
V	Eigen values, Eigen vectors, Cayley Hamilton Theorem, . Bilinear and quadratic form	7

Recommended Books:

1. Linear Algebra Done Right – Sheldon Axler
2. Introduction to Linear Algebra – Gilbert Strang
3. Elementary Linear Algebra: A Matrix Approach – Howard Anton & Chris Rorres
4. Applied Linear Algebra and Matrix Methods – Thomas S. Shores
5. Matrix Analysis– Roger A. Horn & Charles R. Johnson
6 Fundamental of linear Algebra- Sukumar Kumar

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Programme:Class: B.Sc.	Year: Third	Semester: Fifth

Subject: Mathematics

Course Code:	Course Title: Operation Research

1. To develop analytical and problem-solving skills by formulating real-world decision-making problems into mathematical models.
2. To understand and apply optimization techniques such as Linear Programming, Transportation, Assignment, and Network Models for efficient resource utilization.
3. To use quantitative and computational methods for analyzing complex systems and improving organizational performance.
4. To enhance decision-making abilities under constraints and uncertainty using tools like Game Theory, Queuing Theory, and Simulation.
5. To integrate Operations Research software and algorithms for practical problem-solving in business, engineering, and management applications.

Operation Research

Unit	Topic	No of Lectures
I	Introduction to Operations Research and Linear Programming, Definition, scope, and significance of Operations Research, Formulation of Linear Programming Problems (LPP) Graphical Method – Solution of LPP (two-variable problems)	9
II	Simplex Method – Standard form, basic feasible solutions, and optimality conditions, Big M Method, Two phase Methods, Problem of Degeneracy.	8
III	Structure and mathematical formulation of transportation problems, Initial Basic Feasible Solution methods: North-West Corner Rule, Least Cost, and Vogel's Approximation Method (VAM), Optimality test: MODI method, Unbalanced transportation problems and degeneracy, Assignment problems: formulation, Hungarian method, and applications	8
IV	Introduction to Game Theory, Two-person zero-sum games: saddle point, minimax and maximin principle, Games without saddle point: Mixed strategies (2×2 games), Dominance principle and graphical solution methods, Decision theory under risk and uncertainty: Expected value and utility concepts	8
V	Characteristics of Queuing systems and Kendall's notation, Poisson arrival and exponential service distributions, Single server (M/M/1):∞/FIFO model – steady state analysis, Concepts of inventory, costs involved, and EOQ (Economic Order Quantity) models Deterministic and probabilistic inventory models (simple cases)	7

Recommended Books:

1. Operations Research – Kanti Swarup, P.K. Gupta, and Man Mohan
2. Introduction to Operations Research – H.A. Taha
3. Operations Research: Principles and Practice – Ravindran, Phillips & Solberg
4. Operations Research** – S.D. Sharma
5. Quantitative Techniques in Management – N.D. Vohra.

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Programme:Class: B.Sc.	Year: Third	Semester: Fifth
Subject: Mathematics		
Course Code:	Course Title: Graph theory & Discrete Mathematics	

1. To introduce fundamental concepts of discrete structures such as logic, sets, relations, functions, and combinatorics essential for computer science and mathematical reasoning.
2. To develop the ability to model and solve problems using graph theory concepts including connectivity, trees, planar graphs, and coloring.
3. To enhance logical and analytical thinking through the study of propositional logic, predicate logic, and mathematical proofs such as induction and contradiction.
4. To apply discrete mathematical techniques in analyzing algorithms, network structures, and optimization problems in various domains.
5. To prepare students for advanced studies and research by providing a strong foundation in discrete structures and graph-theoretical applications in science and engineering.

Graph theory & Discrete Mathematics

Unit	Topic	No of Lectures
Unit I – Fundamentals of Discrete Mathematics	Introduction to Discrete Mathematics and its applications, Logic: Propositional logic, logical connectives, truth tables, tautologies, and contradictions, Predicates and Quantifiers ,Set theory: operations, Venn diagrams, Cartesian product, and power sets, Relations and Functions: properties, types, composition, and inverse	0
Unit II – Counting Principles and Combinatorics	Basic counting principles: Addition and multiplication rules, Permutations and combinations, Binomial theorem and multinomial theorem, Pigeonhole principle and inclusion-exclusion principle, Recurrence relations and generating functions (basic concepts)	8
Unit III – Graph Theory Fundamentals	Definition and types of graphs: simple, directed, weighted, multigraphs, and pseudographs, Degree of a vertex, subgraphs, and isomorphism, Walks, paths, and circuits, Connected and disconnected graphs, Euler and Hamiltonian paths and circuits, Matrix representation of graphs (adjacency and incidence matrices)	8
Unit IV – Trees and Connectivity	Definition and properties of trees, Spanning trees, minimum spanning tree (Prim's and Kruskal's algorithms), Binary trees and traversal techniques, Cut-sets, cut-vertices, and bridges, Applications of trees in communication and computer networks	8

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	Unit V – Advanced Topics and Applications	Planar graphs and Euler's formula, Graph coloring, chromatic number, and chromatic polynomial, Directed graphs and tournament, Matching and covering in bipartite graphs (Hall's theorem – statement only) Applications of graph theory in computer science and optimization	7

Recommended Books:

1. Narsingh Deo – Graph Theory with Applications to Engineering and Computer Science
2. Kenneth H. Rosen – Discrete Mathematics and Its Applications
3. J.P. Tremblay and R. Manohar – Discrete Mathematical Structures with Applications to Computer Science
4. Seymour Lipschutz – Schaum's Outline of Discrete Mathematics
5. C. L. Liu – Elements of Discrete Mathematics

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	Programme:Class: B.Sc.	**Year: Third**	**Semester: Six**
	Subject: Mathematics		
	Course Code:	**Course Title:** Complex Analysis	

1. To introduce the fundamental concepts of complex numbers and complex functions**, enabling students to understand their algebraic and geometric representations.
2. To develop a deep understanding of analytic functions**, Cauchy-Riemann equations, and the concept of conformal mappings.
3. To apply integral theorems** such as Cauchy's theorem and Cauchy's integral formula for evaluating complex integrals and solving practical problems.
4. To study series expansions of analytic functions**, including Taylor and Laurent series, and use them to analyze singularities and residues.
5. To enable students to apply the residue theorem** and contour integration techniques in evaluating real integrals and solving physical and engineering problems.

Complex Analysis

Unit	Topic	No of Lectures
Unit I –Fundamentals of Complex Numbers and Functions	Complex numbers: algebraic, polar, exponential, and trigonometric forms, Modulus and argument of complex numbers, Functions of a complex variable, limit, continuity, and differentiability, Analytic functions and Cauchy-Riemann equations (Cartesian and polar forms), Harmonic functions and their conjugates	9
Unit II Elementary Functions and Conformal Mapping	Exponential, trigonometric, and hyperbolic functions of a complex variable, Inverse trigonometric and inverse hyperbolic functions, Conformal mapping: definition and properties, Standard transformations: translation, rotation, magnification, and inversion, Bilinear (Mobius) transformations and their geometric significance	8
Unit III – Complex Integration	Concept of contour and contour integration, Cauchy's integral theorem (with proof) and Cauchy's integral formula, Derivatives of analytic functions from Cauchy's formula, Applications of Cauchy's integral formula, Morera's theorem and Liouville's theorem	8
Unit IV – Series Expansions and Singularities	Power series and radius of convergence, Taylor's series and Laurent's series for analytic functions, Singular points and classification: removable, pole, and essential singularities, Zeros of analytic functions and their order, Behavior of functions near singularities.	8
Unit V – Residue Calculus and Applications	Residues and Cauchy's residue theorem, Evaluation of integrals using the residue theorem, Evaluation of real definite integrals using contour integration, Integration around unit circle and semi-circular contours, Applications of residue calculus in physics and engineering.	7

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Recommended Books:

1. Churchill, R.V. & Brown, J.W. – Complex Variables and Applications
2. S. Ponnusamy – Foundations of Complex Analysis
3. Murray R. Spiegel – Schaum's Outline of Complex Variables
4. E.T. Copson – Theory of Functions of a Complex Variable
5. S.L. Loney – Plane Trigonometry and Complex Numbers

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Programme:Class: B.Sc.	Year: Third	Semester: Six
Subject: Mathematics		
Course Code:	Course Title: Numerical Analysis	

1. To introduce numerical methods for solving mathematical problems where analytical solutions are difficult or impossible to obtain.
2. To develop an understanding of error analysis and the importance of numerical stability, accuracy, and convergence in computational techniques.
3. To equip students with numerical techniques for solving equations, interpolation, differentiation, integration, and systems of linear equations.
4. To apply iterative methods for solving non-linear equations and differential equations using suitable algorithms and computational tools.
5. To enable students to implement numerical algorithms using programming or software tools for scientific and engineering problem-solving.

Numerical Analysis

Unit	Topic	No of Lectures
Unit I – Introduction and Error Analysis	Introduction to Numerical Analysis and its importance Types of errors: absolute, relative, and percentage errors, Propagation of errors and condition number Approximation and significant digits, General idea of convergence and stability of numerical methods	9
Unit II – Solution of Non-linear Equations	Bisection method, Regula-Falsi (False Position) method, Iteration method, Newton-Raphson method and its convergence, Secant method and its applications	8
Unit III – Interpolation and Curve Fitting	Finite differences: forward, backward, and central differences, Newton's forward and backward interpolation formulas, Lagrange's interpolation formula, Divided difference and Newton's divided difference formula, Least squares method for curve fitting (linear and quadratic)	8
Unit IV – Numerical Differentiation and Integration	-Numerical differentiation using finite differences, Newton's and Stirling's formulas for derivatives, Numerical integration: Trapezoidal rule, Simpson's 1/3 and 3/8 rules, Error estimation in numerical integration, Applications of numerical integration in physical problems.	8
Unit V – Solution of Linear and Differential Equations	Solution of linear algebraic equations: Gauss elimination, Gauss-Jordan, and Gauss-Seidel method, Jacobi's method and iterative convergence Numerical solution of ordinary differential equations (ODEs), Euler's method, Modified Euler's method Runge-Kutta method (second and fourth order, Introduction to finite difference methods for partial differential equations.	7

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Recommended Books:

1. S.S. Sastry – Introductory Methods of Numerical Analysis
2. M.K. Jain, S.R.K. Iyengar & R.K. Jain – Numerical Methods for Scientific and Engineering Computation
3. B.S. Grewal – Numerical Methods in Engineering and Science
4. E. Balagurusamy – Numerical Methods
5. Francis Scheid – Schaum's Outline of Numerical Analysis

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Programme:Class: B.Sc.	Year: Third	Semester: Six
Subject: Mathematics		
Course Code:	3. Course Title: Differential Geometry	

1. To introduce the fundamental concepts of curves and surfaces in three-dimensional space and their geometric properties such as curvature and torsion.
2. To develop the ability to compute and interpret geometric quantities like tangent, normal, binomial, curvature, and torsion of space curves.
3. To understand the theory of surfaces, including first and second fundamental forms, Gaussian curvature, and mean curvature.
4. To explore the geometric and analytical relationships between curves, surfaces, and coordinate systems using vector calculus and differential equations.
5. To enable students to apply differential geometry concepts in advanced mathematical modeling, theoretical physics, and engineering fields such as relativity and computer graphics.

Differential Geometry

Unit	Topic	No of Lectures
Unit I – Introduction to Differential Geometry and Curves	Introduction and significance of Differential Geometry, Space curves and their representations, Parametric equations of curves, Tangent, normal, and binomial vectors, Curvature and torsion of a curve, Serret–Frenet formulas and their geometrical interpretation	9
Unit II – Curvature and Torsion Applications	Curvature of plane curves and space curves, Osculating plane and normal plane, Circle of curvature and radius of curvature, Evolutes and involutes of curves, Helices and Bertrand curves, Fundamental theorem of space curves (statement and significance	8
Unit III – Theory of Surfaces	Definition and representation of surfaces, Regular surfaces and tangent planes, First fundamental form of a surface, Normal to a surface, Angle between two surfaces, Orthogonal trajectories of surfaces	8
Unit IV – Curvatures of Surfaces	Second fundamental form and its coefficients, Normal curvature, principal curvatures, and lines of curvature, Gaussian curvature and mean curvature, Minimal surfaces, Geodesic curvature and geodesics on a surface	8
Unit V – Advanced Topics and Applications	Isometries and conformal mappings of surfaces, Geodesic equations and differential forms, Dupin indicatrix and its applications, Introduction to Riemannian geometry (basic concepts only), Applications of differential geometry in physics, engineering, and computer graphics	7

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Recommended Books:

1. T.J. Willmore – An Introduction to Differential Geometry
2. D. Somasundaram – Differential Geometry: A First Course
3. Erwin Kreyszig – Differential Geometry
4. M. Lipschutz – Schaum's Outline of Differential Geometry
5. B.B. Sinha– An Introduction to Modern Differential Geometry

Subject: Practical

Each semester will include a 'Practical' paper worth 2 credits with a maximum of 50 marks. The practical component focuses on applying mathematical concepts through computational tools, problem-solving exercises, and project-based learning.

SEMESTER	SUBJECT	CREDIT / MAX MARKS
I	Practical (Mathematics)	2/50
II	Practical (Mathematics)	2/50
III	Practical (Mathematics)	2/50
IV	Practical (Mathematics)	2/50
V	Practical (Mathematics)	2/50
VI	Project(Mathematics)	2/50

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Practical Syllabus B.Sc.:

Year: I, Semester: I

1. Verification of limit of a function using numerical methods and graphical approach.
2. Study of continuity and types of discontinuity for various elementary functions.
3. Verification of Cauchy's and Heine's definitions of limit through problem-based activities.
4. Practical demonstration of Rolle's, Lagrange's, and Cauchy Mean Value Theorems using graphs and calculations.
5. Application of Taylor and Maclaurin series to approximate functions and compare errors.
6. Successive differentiation and verification of Leibnitz Rule through solved examples.
7. Computation and plotting of tangent, normal, curvature, radius of curvature, and asymptotes for given curves.
8. Plotting and analysis of circular, hyperbolic, and inverse hyperbolic functions.
9. Practical problems on complex numbers: Polar form, De Moivre's theorem, logarithm of complex numbers.
10. Basics of computers (MS office: Excel, MS-Word, Power point Presentation etc.)

Year: I, Semester: II

List of Practical's

1. Verification of monotonic and bounded sequences with numerical examples.
2. Determination of limit superior and limit inferior for given sequences.
3. Testing convergence of non-negative term series using Comparison and Ratio tests.
4. Application of Cauchy's Integral Test and Raabe's Logarithmic Test on given series.
5. Evaluation of alternating series using Leibnitz's theorem and testing absolute/conditional convergence.
6. Computation of definite integrals as limits of sums and evaluation of Beta and Gamma functions.
7. Classification and convergence testing of improper integrals using μ-test, Abel's test, and Dirichlet's test.
8. Evaluation of Riemann integrals and verification of Fundamental Theorem of Integral Calculus.
9. Calculation of double and triple integrals including change of order using Dirichlet's and Liouville's theorems.
10. Computation of rectification, volume, and surface area of solids of revolution; differentiation under the integral sign.

Year: II, Semester: III

List of Practical's:

1. Verification of equivalence relations, partitions, and congruence modulo m with examples.
2. Study of groups with real-life examples; identification of subgroups and generators.
3. Construction and verification of cyclic groups, homomorphism's, isomorphism's, and the Fundamental Theorem of Isomorphism.
4. Computation of permutations, identification of even and odd permutations, and study of the alternating group.
5. Verification of Cayley's theorem and computation of direct products of groups.
6. Illustration of coset decomposition and verification of Lagrange's theorem, Fermat's and Euler's theorems.
7. Evaluation of limits and continuity of functions of two variables using numerical examples.
8. Differentiation of functions of two variables and verification of necessary and sufficient conditions for differentiability; Schwarz and Young theorems.
9. Application of Taylor's theorem for functions of two variables; finding maxima, minima using

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Lagrange multipliers; computation of Jacobians.
10. Exploration of metric spaces: examples, sequences, Cauchy sequences, and understanding completeness in metric spaces.

Year: II, Semester: IV

List of Practical's:
1. Formation of differential equations from given families of curves and understanding their geometrical meaning.
2. Solving first-order differential equations using variable separation, homogeneous form, exact equations, and linear equations.
3. Reduction of non-exact differential equations to exact form and verification through integrating factors.
4. Solving second-order linear differential equations with variable coefficients using known solutions, normal form, undetermined coefficients, and variation of parameters.
5. Solving higher-order linear differential equations with constant coefficients and computing particular integrals.
6. Exploration of homogeneous linear differential equations with constant coefficients through real and complex root cases.
7. Determining automorphisms, inner automorphisms, and automorphism groups of finite and infinite cyclic groups.
8. Construction and verification of characteristic subgroups and commutator subgroups along with applications to factor groups.
9. Identification of rings, subrings, integral domains, fields, and computation of characteristic of a ring; verification of ring homomorphism.
10. Working with polynomial rings: division algorithm, reducibility tests, Eisenstein criterion, and unique factorization in Z[x].

Year: III, Semester: V

List of Practical's:
1. Let V be the set of all 2×2 matrices with real entries. Show that V is a vector space over $\mathbb{R}$ under the usual matrix addition and scalar multiplication. Find its dimension and exhibit a basis.

2. In $\mathbb{R}^4$, let S = {(1,1,1,1), (1,2,3,4), (1,3,5,7), (2,3,4,5)}. Determine whether S is linearly independent or dependent. If dependent, find a non-trivial linear dependence relation. Hence find a basis and the dimension of span(S).

3. Let U = span{(1,0,1,0), (0,1,1,0)} and W = span{(0,0,1,1), (1,1,0,0)} in $\mathbb{R}^4$. Prove that $\mathbb{R}^4 = U \oplus W$ (direct sum).

4. Let T: $\mathbb{R}^3 \to \mathbb{R}^3$ be the linear transformation defined by T(x,y,z) = (x+y, y+z, x+z).
   (a) Find the matrix of T with respect to the standard basis.
   (b) Find ker(T) and im(T).
   (c) Verify the Rank-Nullity theorem for T.

5. Let T: $P_2(\mathbb{R}) \to P_2(\mathbb{R})$ be defined by T(p(t)) = p'(t) (derivative). Find the matrix representation of T with respect to the basis $\{1, t, t^2\}$. Also find rank(T) and nullity(T).

6. In $\mathbb{R}^3$ with standard inner product, apply the Gram-Schmidt process to the vectors (1,1,1), (1,1,0), (1,0,0) to obtain an orthonormal basis. Then, for the vector v = (2,3,4), verify Bessel's inequality using this orthonormal set.

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7. Consider the matrix A = [[1, 2, 3], [2, 4, 6], [3, 6, 8]].
(a) Reduce A to row echelon form and hence find rank(A).
(b) Determine whether the system $Ax = [1, 1, 2]^T$ is consistent. If yes, find the general solution.

8. Let A be a 3×3 matrix with eigenvalues 2, 2, 3. Suppose one eigenvector corresponding to $\lambda = 2$ is $(1,0)^T$. Find a basis of $\mathbb{R}^3$ consisting of eigenvectors of A if A is diagonalizable; otherwise prove it is not.

9. Verify the Cayley-Hamilton theorem for the matrix
B = [[5, 4, 1], [0, 3, 2], [0, 0, 3]].
Also find B^{-1} using the Cayley-Hamilton theorem.

10. Consider the quadratic form $Q(x,y,z) = 2x^2 + 3y^2 + 3z^2 - 2xy - 2xz + 2yz$.
(a) Write Q in matrix form as X^TAX.
(b) Find the eigen values of A and hence classify Q as positive definite, negative definite, or indefinite.

Year: III, Semester: VI

List of Practical's:

1. Algebraic and Geometric Forms, Argument, De Moivre
2. Analytic Functions, Cauchy-Riemann Equations (Cartesian & Polar)
3. Complex Exponential, Trigonometric, Hyperbolic and Inverse Functions
4. Conformal Mapping and Standard Transformations
5. Contour Integration and Cauchy's Theorems
6. Higher Derivatives, Morera's and Liouville's Theorems
7. Power Series, Taylor and Laurent Series Expansions
8. Classification of Singularities and Zeros
9. Residues and Cauchy Residue Theorem
10. Real Definite Integrals via Contours

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Software Required – Semester-wise

Year I – Semester I

- GeoGebra Classic 6 (Open Source Free)
- Programming in C
- Desmos (Online Graphing Calculator)
- Wolfram Alpha (Web)
- MS Office (Word, Excel, PowerPoint)

Year I – Semester II

- C, C++
- GeoGebra
- Wolfram Alpha
- MS Word, MS Excel

Year II – Semester III

- Python (Anaconda – SymPy, NumPy)
- GeoGebra 3D
- GAP Software (for Group Theory)
- Desmos (optional)

Year II – Semester IV

- MATLAB / GNU Octave / Scilab
- Python (SymPy + SciPy)
- GAP Software
- GeoGebra CAS

Year III – Semester V

- MATLAB / GNU Octave
- Python (NumPy, SymPy, Matplotlib)
- GeoGebra
- Wolfram Alpha
- MS Excel (optional)

Year III – Semester VI

- MATLAB / GNU Octave
- Python (SymPy + mpmath)
- GeoGebra (Complex Function Plotting)
- Complex Grapher / Winplot
- Wolfram Alpha

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FSEC301	AI FOR EVERYONE	L T P 2 0 0	2 credits

CourseObjectives:

CO1	**Introduce** fundamental concepts of Artificial Intelligence (AI) and its real-world applications.
CO2	**Familiarize** students with basic AI techniques such as machine learning, natural language processing, and computer vision.
CO3	**Enhance** understanding of ethical considerations and societal impacts of AI.
CO4	**Develop** problem-solving skills using AI tools and frameworks.
CO5	**Encourage** critical thinking about the future of AI in various domains such as healthcare, education, business, and security.

Unit-I

Introduction to AI (Concept + Hands-on): What is AI? Understanding AI vs. Machine Learning vs. Deep Learning, AI in daily life: Smart assistants, AI in social media, AI in e-commerce, Prompt Engineering, Real Life Applications of AI.Tools: Explore AI-based tools (Google AI, ChatGPT ,MetaAI,Gemini).

Unit-II

Introduction to Machine Learning and Deep Learning: Introduction to learning theory, Methods and Models.Supervised vs. Unsupervised Learning (Examples from real life), Reinforcement Learning, Introduction to ANN and Deep Learning.

Unit-III

Computer Vision & Image Processing: Introduction to Image processing and Computer Vision ?, Hardware used, Face Recognition, Object Detection, and AI-powered Cameras, How AI understands text & speech, AI in Chatbots, Sentiment Analysis, and AI-based Translation Practical

Unit-IV

AI in Automation & Robotics: AI-powered automation in businesses, How AI is used in robotics and smart homes, Ethical AI & Responsible AI, Bias in AI and fairness in decision-making, How to use AI responsibly.

Unit-V

Mini AI Projects (Without Coding): Hands-on Project Options: AI for Image Classification: Train an AI model to recognize objects Create an AI Chatbot:Use Dialog flow or Chatbot.com AI in Business: Automate tasks using AI-based productivity tools.

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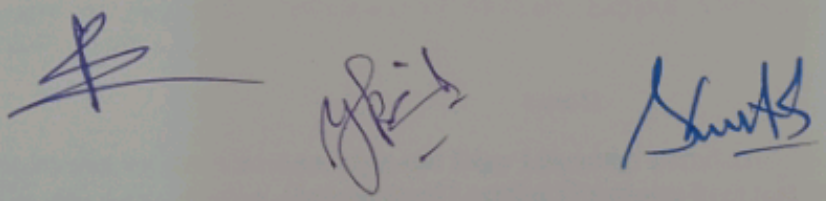
***Students will present their AI Project (Simple AI-based tool using existing platforms) Complete an AI-based quiz & get a certification.**

TextbooksandReferences:

1. **Stuart Russell & Peter Norvig** – *Artificial Intelligence: A Modern Approach* (Pearson, 4th Edition)
2. **John Paul Mueller & Luca Massaron** – *Artificial Intelligence For Dummies* (Wiley)"A beginner-friendly guide to AI concepts, applications, and future trends."
3. **Thomas H. Davenport &Nitin Mittal** – *All in on AI: How Smart Companies Win Big with Artificial Intelligence* (Harvard Business Review Press), Explains AI strategies in business and industry.

COURSEOUTCOMES:

CO1	**Understand** the fundamental principles and applications of AI in different industries.
CO2	**Explain** key AI techniques, including supervised and unsupervised learning, deep learning, and neural networks.
CO3	**Analyze** ethical challenges and biases in AI systems and their impact on society.
CO4	**Apply** AI-driven solutions in fields like healthcare, finance, and automation.
CO5	**Critically evaluate** the benefits and risks associated with AI technologies.



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B020405T	AI FOR SCIENCE	L T P 2 0 0	2 credits

CourseObjectives:

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CO2	**Familiarize** students with basic AI techniques such as machine learning, natural language processing, and computer vision and applications in Science.
CO3	**Enhance** understanding of ethical considerations and societal impacts of AI.
CO4	**Develop** problem-solving skills using AI tools and frameworks.
CO5	**Encourage** critical thinking about the future of AI in various domains as science and healthcare.

Unit-I

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Unit-II

Introduction to Machine Learning and Deep Learning: Introduction to learning theory, Methods and Models.Supervised vs. Unsupervised Learning (Examples from real life), Reinforcement.Computer applications in Science.

Unit-III

Computer Vision & Image Processing: Introduction to Image processing and Computer Vision ?, Hardware used, Face Recognition, Object Detection, and AI-powered Cameras, How AI understands text & speech, AI in Chatbots, Sentiment Analysis, and AI-based Translation Practical applications in Science and Research.

Unit-IV

AI in Automation & Robotics: AI-powered automation in businesses, How AI is used in robotics and smart homes, Ethical AI & Responsible AI, Bias in AI and fairness in decision-making, How to use AI responsibly in understanding the Scientific domains.

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Unit-V

Mini AI Projects (Without Coding): Hands-on Project Options:
AI for Image Classification: Train an AI model to recognize objects

Create an AI Chatbot:Use Dialog flow or Chatbot.com
AI in Science: Automate tasks using AI-based productivity tools.
***Students will present their AI Project (Simple AI-based tool using existing platform.)**

Complete an AI-based quiz & get a certification.

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CO2	**Explain** key AI techniques, including supervised and unsupervised learning and understanding of scientific research domains.
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CO4	**Apply** AI-driven solutions in fields like healthcare industry.
CO5	**Critically evaluate** the benefits and risks associated with AI technologies.

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https://nptel.ac.in/courses/104/106/104106096/

Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .

Or
Assessment and presentation of Assignment (10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10
(average of all 04 unit tests)
(10 marks)

Overall performance throughout the semester (Discipline,
participation in different activities)
(05 marks)

Course prerequisites: To study this course, a student must have had the chemistry in class 12 th , Physics in Class 12th

COURSE OUTCOMES:

CO1	To gain an understanding of organic reactions and their applications.
CO2	This course will provide a broad foundation in for the synthesis of drugs and other medicinally important compounds. l
CO3	Students will gain an understanding of natural products and their uses. .
CO4	This course will be useful for understanding of electrochemistry and surface chemistry.
CO5	To develop basic knowledge of radiochemistry.

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