



Board of Studies

(Including Proceeding, Course Structure, Course Curriculum and Evaluation Scheme)

For

B.Sc. (PCM)

(Effective from the Session: 2026–27)

FUTURE UNIVERSITY, BAREILLY

Faculty of Science

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Dean
Faculty of Sciences
Future University
Bareilly



Date : - 27-07-2026

To

The Hon'ble Vice-Chancellor,
Future University, Bareilly
Through: Dean, Faculty of Science

Subject: Request for Permission to Conduct the Board of Studies (BoS) Meeting for B.Sc. (PCM)

Respected Sir,

With due respect, this is to seek your kind permission to convene a meeting of the Board of Studies (BoS) for the B.Sc. (PCM) programme under the Faculty of Science.

The purpose of the meeting is to review and approve the proposed course structure, syllabus, and academic regulations for the programme in accordance with UGC guidelines and the National Education Policy (NEP) 2020.

It is proposed to conduct the BoS meeting on 28-07-2026 in the Board Room, Future University, Bareilly.

Kind approval is requested to proceed with the necessary arrangements and to issue the formal notification for the same.

Thanking you for your kind consideration.

Yours sincerely,


Prof. (Dr.) Yogendra Kumar Singh

Dean, Faculty of Science

Future University, Bareilly

Dean
Faculty of Sciences
Future University
Bareilly





Agenda

Faculty of Science

Meeting Agenda of Board of Studies

Programme: B.Sc. (PCM)

Dated: 28-07-2026

1. To review and recommend the course structure and curriculum of B.Sc. (PCM) for the session 2026–27, taking into consideration NEP 2020 guidelines.
2. To discuss the total credits to be taken for the programme, based on the decision taken in the meeting of all the Deans.
3. To assess the comprehensive and continuous evaluation and assessment scheme for the students.
4. To finalise the Vocational and Co-curricular papers across the semesters, as detailed in the proposed course structure.
5. Any other item with the permission of the Chair.

Prof. (Dr.) Yogendra Kumar Singh
Dean, Faculty of Science

Future University, Bareilly

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Date :- 27-07-2026

To,

Dr. Pushpender Kumar Gangwar
Department of Physics
Bareilly College, Bareilly

Sub: Invitation as an Expert in the Board of Studies (BoS) of B.Sc. (PCM).

Sir,

The Vice-Chancellor, Future University, Bareilly, has approved a recommendation that you be appointed as an External Expert Member for the Board of Studies meeting of the B.Sc. (PCM) programme, Faculty of Science, Future University, Bareilly. The proposed date of the BoS meeting is 28-07-2026 from 10:00 AM onwards at the University Campus (Board Room). You are requested to kindly accept the invitation as an External Expert for the said meeting. The schedule of the meeting is as follows:

Date: 28-07-2026

Time: 10:00 AM

Venue: Board Room, Future University, Bareilly.

A line of acknowledgement of acceptance will be highly appreciated.

Thanks and Best Regards,

Prof. (Dr.) Yogendra Kumar Singh

Dean, Faculty of Science
Future University, Bareilly
Dean
Faculty of Sciences
Future University
Bareilly



Date :- 27-07-2026

To,

Dr. Chitrendu Ji Tripathi
Department of Chemistry
Bareilly College, Bareilly

Sub: Invitation as an Expert in the Board of Studies (BoS) of B.Sc. (PCM & ZBC).

Sir,

The Vice-Chancellor, Future University, Bareilly, has approved a recommendation that you be appointed as an External Expert Member for the Board of Studies meeting of the B.Sc. (PCM) programme, Faculty of Science, Future University, Bareilly. The proposed date of the BoS meeting is 28-07-2026 from 10:00 AM onwards at the University Campus (Board Room). You are requested to kindly accept the invitation as an External Expert for the said meeting. The schedule of the meeting is as follows:

Date: 28-07-2026

Time: 10:00 AM

Venue: Board Room, Faculty of Science, Future University, Bareilly.

A line of acknowledgement of acceptance will be highly appreciated.

Thanks and Best Regards,


Prof. (Dr.) Yogendra Kumar Singh
Dean, Faculty of Science

Future University, Bareilly
**Dean
Faculty of Sciences
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Bareilly**



4. Board of Studies

B. Sc. (PCM)

S.N.	Position	Designation	Proposed Member, Designation, Affiliation
1	Senior Faculty	Chairperson	Prof. (Dr.) Yogendra Kumar Singh, Dean, Faculty of Science, Future University, Bareilly.
2	Senior Faculty	Senior Member	Prof. (Dr.) Manish Kumar Singh, Faculty of Science, Future University, Bareilly.
3	Senior Faculty	Member Secretary	Prof. (Dr.) Shalabh Saxena, Future University, Bareilly.
4	Academic Expert (Member)	Member	Dr. Pushpender Kumar Gangwar, Department of Physics, Bareilly College, Bareilly.
5	Academic Expert (Member)	Member	Dr. Chitrendu Ji Tripathi, Department of Chemistry, Bareilly College, Bareilly.

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5. Attendance List of BoS Members

B.Sc. (PCM)

S.N.	Name of Member	Designation / Affiliation	Signature
1	Prof. (Dr.) Yogendra Kumar Singh	Dean, Faculty of Science, Future University, Bareilly.	
2	Prof. (Dr.) Manish Kumar Singh	Professor, Faculty of Science, Future University, Bareilly.	
3	Prof. (Dr.) Shalabh Saxena	Professor, Faculty of Science, Future University, Bareilly.	
4	Dr. Pushpender Kumar Gangwar	Associate Professor, Department of Physics, Bareilly College, Bareilly.	joined online
5	Dr. Chitrendu Ji Tripathi	Associate Professor, Department of Chemistry, Bareilly College, Bareilly.	joined online.



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6. Budget of Board of Studies

B.Sc. (PCM)

S. No.	Particulars	Amount	Pack	Total
1	Remuneration to External Experts (including TA for local experts, otherwise 5,000 + TA)	5,000	02	10,000
2	Refreshment / Working Lunch	1,000	01	1,000
3	Stationery and Printing	500	01	500
			Grand Total	11,500

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7. Point of Discussion

S. No.	Point of Discussion	Sub Point
1	Review and Approval of Scheme and Syllabus of B.Sc. (PCM) (Batch 2026 onwards)	Subject code & syllabus will be defined for the programme and will be adopted as per UGC guidelines and the NEP 2020 credit framework.




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8. Minutes of Meeting

B.Sc. (PCM)

Particulars	Details
Date	28-07-2026
Time	10:00 AM
Venue	Borad Room, Future University, Bareilly
Chairperson	Dean, Faculty of Science

Panel of BoS Attendees:

As per the Attendance List of BoS Members (Section 5).

The following are the details of the discussions held:

1. As this is the first meeting of the Board of Studies for this programme, there were no previous minutes to be confirmed.
2. The proposed course structure and syllabus for B.Sc. (PCM), for the session 2026–27 and for all semesters, was discussed threadbare. Suggestions given by the external experts were incorporated at various places, including greater emphasis on practical/laboratory components.
3. The total credits for the programme were discussed and finalised in line with the decision taken in the meeting of all the Deans and NEP 2020 guidelines.
4. After discussion, it was agreed that evaluation for each theory paper will be out of 100 marks, comprising 30 marks for internal continuous evaluation and 70 marks for end-semester examination; practical papers will be evaluated out of 50 marks (15 internal, 35 end-semester).
5. The Vocational and Co-curricular/Elective papers across semesters, as proposed in the course structure, were reviewed and approved.

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Any other item with the permission of the Chair:

- Course work and practicals will carry codes as per UGC suggestions for Academic Bank of Credits (ABC) purposes.
- It was suggested that the University should follow the NCrF (National Credit Framework) structure across all programmes offered.
- Practical credit shall be assigned as per UGC norms.
- The Board appreciated the efforts of the Faculty members in formulating the syllabus for the 2026–27 academic batch. The Member Secretary informed the Board that the detailed syllabi for the remaining semesters shall be presented for approval in subsequent BoS meetings, in consultation with subject experts, and placed before the Academic Council thereafter.

The meeting ended with a vote of thanks to the external members who spared their valuable time and offered valuable suggestions.


Prof. (Dr.) Yogendra Kumar Singh
Dean, Faculty of Science
Future University, Bareilly

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9. Course Structure / Scheme

B.Sc. (PCM)

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Year	Semester	Course Code	Paper Title	Theory/ practical	L	T	P	Credit
First Year	First	BPH1105	Mathematical Physics & Newtonian Mechanics	Theory	3	1	0	4
		BPH1173	Mechanical Property of Matter	Practical	0	0	2	2
	Second	BPH1205	Electromagnetic Theory	Theory	3	1	0	4
		BPH1273	Demonstrative aspects of Electricity and Magnetism	Practical	0	0	2	2
Second Year	Third	BPH2305	Physical Optics, Laser and Fiber Optics	Theory	3	1	0	4
		BPH2373	Demonstrative aspects of optics	Practical	0	0	2	2
	Fourth	BPH2405	Circuit Fundamental and Basic semiconductor Electronics	Theory	3	1	0	4
		BPH2473	Basic Electronics instrumentation	Practical	0	0	2	2
Third Year	Fifth	BPH3505	Thermodynamic and Statistical Mechanism	Theory	3	1	0	4
		BPH3506	Semiconductor physics and Digital Electronics	Theory	3	1	0	4
		BPH3573	Thermal property of matter and Digital Electronics	Practical	0	0	2	2
	Sixth	BPH3605	Solid state and Nuclear Physics	Theory	3	1	0	4
		BPH3606	Quantum Mechanics and Spectroscopy	Theory	3	1	0	4
		BPH3673	Project Work	Practical	0	0	2	2




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Year	Semester	Course Code	Paper Title	Theory/ practical	L	T	P	Credit
First Year	First	BMT1104	Differential Calculus and Trigonometry	Theory	3	1	0	4
		BMT1174	Practical based on course	Viva	0	0	0	2
	Second	BMT1204	Sequence and Series and Integral Calculus	Theory	3	1	0	4
		BMT1274	Viva based on course	Viva	0	0	0	2
Second Year	Third	BMT2304	Algebra and real analysis	Theory	3	1	0	4
		BMT2374	Viva based on course	Viva	0	0	0	2
	Fourth	BMT2404	Differential Equation and Modern Algebra	Theory	3	1	0	4
		BMT2474	Viva based on course	Viva	0	0	0	2
Third Year	Fifth	BMT3504	Matrix and Linear Algebra	Theory	3	1	0	4
		BMT3503	Operation Research / Graph Theory and Discrete Mathematics	Theory	3	1	0	4
		BMT3574	Viva based on course	Viva	0	0	0	0
	Sixth	BMT3603	Complex Analysis	Theory	3	1	0	4
		BMT3604	Numerical Analysis / Differential Geometry	Theory	3	1	0	4
		BMT3674	Viva based on course	Viva	0	0	0	2




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Year	SEM	Course Code	Paper Title	Theory/ practical	L	T	P	Credit
First Year	First	BCHE1101	Structure and Bonding Organic Chemistry I	Theory	3	1	0	4
		BCHE1172	Qualitative analysis (Physical and Volumetric) Qualitative Analysis (Inorganic and Organic)	Practical	0	0	2	2
	Second	BCHE1203	Inorganic Chemistry –I Physical Chemistry -I	Theory	3	1	0	4
		BCHE1273	Chemistry Practical –II Qualitative analysis (Physical and Volumetric) Qualitative Analysis (Inorganic and Organic)	Practical	0	0	2	2
Second Year	Third	BCHE2301	Chemistry Dynamics and Coordination Chemistry	Theory	3	1	0	4
		BCH2370	Lab Work Based on Course Chemistry	Practical	0	0	2	2
	Fourth	BCH2401	Quantum Mechanics Spectroscopy and Analytic Techniques	Theory	3	1	0	4
		BCH2471	Lab Work Based on (Quantum mechanics spectroscopy and analytic techniques)	Practical	0	0	2	2
Third Year	Fifth	BCH3501	Organic Synthesis A	Theory	3	1	0	4
		BCH3506	Rearrangement and chemistry of Group Element	Theory	3	1	0	4
		BCH3572	Qualitative analysis	Practical	0	0	2	2
	Sixth	BCH3601	Organic Synthesis B	Theory	3	1	0	4
		BCH3606	Chemical Energetics and radiochemistry	Theory	3	1	0	4
		BCH3671	Lab Work Based on Course	Practical	0	0	2	2




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Evaluation Scheme

B. Sc. (PCM and ZBC)

S. N.	Subject	Internal	External	Total
1	Physics	30	70	100
2	Chemistry	30	70	100
3	Mathematics	30	70	100
4	Zoology	30	70	100
5	Botany	30	70	100
6	Vocational	100	--	100
7	Co-curricular	40	60	100



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10. Syllabus

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SYLLABUS — B.Sc. PHYSICS

Semester-wise Titles of the Papers in UG Physics Course

Year	Semester	Paper Title	Theory/Practical	Credit
First	I	Mathematical Physics & Newtonian Mechanics	Theory	4
First	I	Mechanical Properties of Matter	Practical	2
First	II	Electromagnetic Theory	Theory	4
First	II	Demonstrative Aspects of Electricity & Magnetism	Practical	2
Second	III	Physical Optics, Laser and Fiber Optics	Theory	4
Second	III	Demonstrative Aspects of Optics	Practical	2
Second	IV	Circuit Fundamentals and Basic Semiconductor Electronics	Theory	4
Second	IV	Basic Electronics Instrumentation	Practical	2
Third	V	Thermodynamics and Statistical Mechanics	Theory	4
Third	V	Semiconductor Physics and Digital Electronics	Theory	4
Third	V	Thermal Properties of Matter and Digital Electronics	Practical	2
Third	VI	Solid State & Nuclear Physics	Theory	4
Third	VI	Quantum Mechanics and Spectroscopy	Theory	4
Third	VI	Project Work	Project	2

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Year	First
Semester	First
Subject	Physics (THEORY)
Course Code	BPH1105
Course Title	Mathematical Physics & Newtonian Mechanics

Course Objectives (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 vector 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 significances, 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.	9
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,	7

	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).	
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 (PRACTICAL)
Course Code	BPH1175
Course Title	Mechanical Properties of Matter

Course Objectives (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.

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(THEORY)
Course Code	BPH1205
Course Title	Electromagnetic Theory

Course Objectives (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	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	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	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
IV	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	Electromagnetic waves EM wave equations in vacuum, Solution of EM wave equation, Plane EM	8

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	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.	
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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 (PRACTICAL)
Course Code	BPH1275
Course Title	Demonstrative Aspects of Electricity and Magnetism

Course Objectives (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.

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(THEORY)
Course Code	BPH2305
Course Title	Physical Optics, Laser and Fiber Optics

Course Objectives (COs)

1. Study of coherence and interference of light.
2. Study of Fresnel and Fraunhofer 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
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	6

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(MMF) and Single mode Fiber (SMF), Propagation through fiber, Acceptance angle and Numerical Aperture, Fiber losses, Attenuation, Applications of optical fiber.	
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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 (PRACTICAL)
Course Code	BPH2375
Course Title	Demonstrative aspects of Optics

Course Objectives (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.

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 (THEORY)
Course Code	BPH2405
Course Title	Circuit fundamentals and Basic Semiconductor Electronics

Course Objectives (COs)

1. Understanding D.C. circuits and Network theorems, Utility of AC bridges.
2. Study of semiconductors and power supply.
3. Understanding 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
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	

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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.

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.
4. V. K. Mehta, Principles of Electronics, S. Chand Publication.

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Year	Second
Semester	Fourth
Subject	Physics (PRACTICAL)
Course Code	BPH2475
Course Title	Basic Electronics Instrumentation

Course Objectives (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.

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 (THEORY)
Course Code	BPH3507
Course Title	Paper 1 (Thermodynamics and Statistical Mechanics)

Course Objectives (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 physical 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 (Clausius Clapeyron equation, Joule Thomson coefficient).	9
III	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
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 function, Relation between partition function and thermodynamic potentials.	7

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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
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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 (THEORY)
Course Code	BPH3508
Course Title	Paper 2 (Semiconductor Physics and Digital Electronics)

Course Objectives (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 complement, Binary Multiplication, Boolean algebra.	8
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 Subtractor, Full Subtractor. Data Processing Circuits: Multiplexer,	7

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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 (PRACTICAL)
Course Code	BPH3576
Course Title	Thermal properties of matter and digital electronics

Course Objectives (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.

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 (THEORY)
Course Code	BPH3607
Course Title	Paper 1 (Solid State and Nuclear Physics)

Course Objectives (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
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	8

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	Synchrotron. Detectors: Theory, working and applications of Bubble chamber, GM counter, Scintillation counter and Wilson cloud chamber. Classification of elementary particles.	
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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 (THEORY)
Course Code	BPH3608
Course Title	Paper 2 (Quantum Mechanics and Spectroscopy)

Course Objectives (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, Davisson 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 significance 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 harmonic oscillator.	9
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	7

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alkaline elements: Singlet and triplet structure of spectra.
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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 Murugesan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e
4. H.E. White, "Introduction to Atomic Spectra", McGraw Hill, 1934
5. S.L. Gupta, V. Kumar, R.C. Sharma, "Elements of Spectroscopy", Pragati Prakashan, Meerut, 2015, 27e
6. Rajkumar, "Atomic and Molecular Physics", Campus books international

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Year	Third
Semester	Sixth
Subject	Physics (PROJECT)
Course Code	BPH3676
Course Title	Project work

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SYLLABUS — B.Sc. MATHEMATICS

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 Objectives (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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Semester Wise Titles of the Paper in UG Mathematics Course

Semester	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
V	Any One of The Following: (i) Operation Research (ii) Graph Theory & Discrete Mathematics	THEORY	4
VI	Complex Analysis	THEORY	4
VI	Any one of the Following: 1. Numerical Analysis 2. Differential Geometry	THEORY	4

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Year	First
Semester	First
Subject	Mathematics
Course Code	BPT1104
Course Title	Differential Calculus & Trigonometry

Course Objectives (COs)

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.

Unit	Topics	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.	
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.	
III		

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	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, Exponential Value of sine and cosine, Circular & Hyperbolic Function.	8
V	Inverse Circular and Inverse Hyperbolic Functions, Logarithms of Complex Quantities.	

Suggested Readings

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

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Year	First
Semester	Second
Subject	Mathematics
Course Code	BMT1204
Course Title	Sequence & Series and Integral Calculus

Course Objectives (COs)

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.
3. 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.
4. 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.
5. 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.
6. Multivariable Integral Calculus: Students will gain an understanding of double and triple integrals, as well as their applications in areas such as physics, engineering, and geometry.

Unit	Topics	No. of Lectures
I	Definition of a sequence, theorems on limits of sequences, bounded and monotonic sequences, Cauchy's convergence criterion, Cauchy sequence, 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,	8

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	Fundamental theorem of integral calculus, Mean value theorems of integral calculus.	
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

Suggested Readings

1. Course Books published in Hindi may be prescribed by the Universities.
2. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2007.
3. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc., 2002.
4. S. Balachandra Rao & C. K. Shantha, Differential Calculus, New Age Publication.
5. T.M. Apostol, Calculus Vol. II, John Wiley Publication
6. Shanti Narayan & Dr. P.K. Mittal, Integral Calculus, S.Chand
7. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
8. H.K Das Engineering Mathematics S. Chand.
9. R.G. Bartle & D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons

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Year	Second
Semester	Third
Subject	Mathematics
Course Code	BMT2304
Course Title	Algebra & Real Analysis

Course Objectives (COs)

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 used 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.

Unit	Topics	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.	6
V	Metric spaces: Definition and examples, Sequences in metric spaces, Cauchy sequences, Complete metric space.	7



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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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Year	Second
Semester	Fourth
Subject	Mathematics
Course Code	BMT2404
Course Title	Differential Equation & Modern Algebra

Course Objectives (COs)

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.

Unit	Topics	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 coefficients, 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	7

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factorization in $\mathbb{Z}[x]$.	
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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 platform: 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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Year	Third
Semester	Fifth
Subject	Mathematics
Course Code	BMT3504
Course Title	Linear Algebra and Matrix

Course Objectives (COs)

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 and some 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.

Unit	Topics	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.	8

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Suggested Readings

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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Year	Third
Semester	Fifth
Subject	Mathematics
Course Code	BMT3505
Course Title	Operation Research (Elective)

Course Objectives (COs)

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.

Unit	Topics	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		7

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	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).	
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Suggested Readings

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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Year	Third
Semester	Fifth
Subject	Mathematics
Course Code	BMT3506
Course Title	Graph theory & Discrete Mathematics (Elective)

Course Objectives (COs)

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.

Unit	Topics	No. of Lectures
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.	9
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
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
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	8

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	and computer networks.	
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

Suggested Readings

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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Year	Third
Semester	Six
Subject	Mathematics
Course Code	BMT3604
Course Title	Complex Analysis

Course Objectives (COs)

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.

Unit	Topics	No. of Lectures
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
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
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
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,	8

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	Behavior of functions near singularities.	
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

Suggested Readings

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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Year	Third
Semester	Six
Subject	Mathematics
Course Code	BMT3605
Course Title	Numerical Analysis (Elective)

Course Objectives (COs)

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.

Unit	Topics	No. of Lectures
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
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
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
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
V	Solution of Linear and Differential Equations	7

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	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.	
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Suggested Readings

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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Year	Third
Semester	Six
Subject	Mathematics
Course Code	BMT3606
Course Title	Differential Geometry (Elective)

Course Objectives (COs)

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.

Unit	Topics	No. of Lectures
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
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
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
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
V	Advanced Topics and Applications Isometries and conformal mappings of surfaces, Geodesic equations and	

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	differential forms, Dupin indicatrix and its applications, Introduction to Riemannian geometry (basic concepts only), Applications of differential geometry in physics, engineering, and computer graphics.	
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Suggested Readings

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

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Practical Exam/ Viva-Voce

Each semester will include a Practical Exam 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 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

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.

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Year: II, Semester: III

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

Year: II, Semester: IV

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, 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 $\mathbb{Z}[x]$.

Year: III, Semester: V

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 $\text{span}(S)$.
3. Let $U = \text{span}\{(1,0,1,0), (0,1,1,0)\}$ and $W = \text{span}\{(0,0,1,1), (1,1,0,0)\}$ in $\mathbb{R}^4$. Prove that $\mathbb{R}^4 = U \oplus W$ (direct sum).
4. Let $T: \mathbb{R}^3 \rightarrow \mathbb{R}^3$ 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 $\text{im}(T)$. (c) Verify the Rank-Nullity theorem for T .
5. Let $T: P_2(\mathbb{R}) \rightarrow P_2(\mathbb{R})$ 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 $\text{rank}(T)$ and $\text{nullity}(T)$.
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.
7. Consider the matrix $A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 6 \\ 3 & 6 & 8 \end{bmatrix}$. (a) Reduce A to row echelon form and hence find $\text{rank}(A)$. (b) Determine whether the system $Ax = \begin{bmatrix} 1 \\ 1 \\ 2 \end{bmatrix}$ 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 $(1,0,1)^T$. 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 $B = \begin{bmatrix} 5 & 4 & 1 \\ 0 & 3 & 2 \\ 0 & 0 & 3 \end{bmatrix}$. 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

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

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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B020405T — AI FOR SCIENCE (L-T-P: 2-0-0, 2 Credits)

Course Objectives:

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 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 such as science and healthcare.

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. 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.

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 Dialogflow 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) and complete an AI-based quiz to get a certification.

Suggested Readings

1. Stuart Russell & Peter Norvig – Artificial Intelligence: A Modern Approach (Pearson, 4th Edition)
2. John Paul Mueller & Luca Massaron – Artificial Intelligence For Dummies (Wiley)

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3. Thomas H. Davenport & Nitin Mittal – All in on AI: How Smart Companies Win Big with Artificial Intelligence (Harvard Business Review Press)

Course Objectives:

CO1	Understand the fundamental principles and applications of AI in different industries.
CO2	Explain key AI techniques, including supervised and unsupervised learning and understanding of scientific research domains.
CO3	Analyze ethical challenges and biases in AI systems and their impact on environment.
CO4	Apply AI-driven solutions in fields like healthcare industry.
CO5	Critically evaluate the benefits and risks associated with AI technologies.

Dr. A. H. Khan
Faculty of Sciences
Future University
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Additional Notes (Related Elective — reference NPTEL course)

Reference: <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 Chemistry in Class 12th and Physics in Class 12th.

Course Objectives:

CO1	To gain an understanding of organic reactions and their applications.
CO2	This course will provide a broad foundation for the synthesis of drugs and other medicinally important compounds.
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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National Education Policy-2020

PROPOSED STRUCTURE OF SYLLABUS

CHEMISTRY

(FACULTY OF SCIENCE)

FUTURE UNIVERSITY, BAREILLY

18th Milestone, Bareilly-Lucknow Highway NH-24

Near Faridpur, Bareilly, Uttar Pradesh 243503

Website: www.futureuniversity.in

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Purpose of the Program: The purpose of the undergraduate chemistry program at the university and college level is to provide the key knowledge base and laboratory resources to prepare students for careers as professionals in various industries and research institutions.

Program's Outcomes:

1. Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in analytical, Inorganic, Organic and Physical Chemistries.
2. Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
3. Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
4. Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
5. Students will appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.
6. Students will be able to explain why chemistry is an integral activity for addressing social, economic, and environmental problems.
7. Students will be able to function as a member of an interdisciplinary problem solving team

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Year I, Semester I, Paper-1 (Theory)

Course Code:	BCH1101	Credits 4
Course Title:	Organic Chemistry, Structure and Bonding	

Subject: Elective:

Max. Marks: 30+70

Total No. of Lectures: 60

UNIT I

Atomic Structure: Schrodinger wave equation; H atom; Radial and angular wave functions: quantum numbers and concept of orbitals; Slater orbitals. Shape of s,p,d orbital, Aufbau and Pauli principle. Chemical Bonding: VB and MO approach of H₂ molecule; MO treatment of homonuclear and heteronuclear (CO & NO) diatomic molecules; Concept of HOMO and LUMO. VSEPR theory; Structure of simple molecules and ions of main group elements.

UNIT II

Ionic Solids: Close packing, Radius ratio rule and crystal coordination number. Examples of MX and MX₂ type ionic solids (NaCl and TiO₂). Metallic Bonding: theories of bonding in metals; Free electron, VB and Band theories. Weak Interactions: Hydrogen bonding and van der Waal's interactions.

UNIT III

Concepts: Atomic orbitals, hybridization, orbital representation of methane, ethane, ethyne and benzene. Polarity of bonds: Inductive, resonance and steric effects hyperconjugation, and their influence on acidity and basicity of organic compounds. Hydrocarbons: Alkanes: Chlorination of methane, Alkenes: Addition reactions (Electrophilic and Free radical), Hydration, hydroxylation, hydroboration, epoxidation and ozonolysis. Alkynes: Reduction, Electrophilic addition, acidity and metal acetylides. Conjugated and isolated Dienes: 1,2- versus 1,4-addition. Diels - Alder reaction.

UNIT IV

Alkyl Halides: Nucleophilic substitution: SN₁, SN₂ mechanisms; Eliminations reactions: E₁ and E₂ mechanisms, Elimination versus substitution reactions; energy profile diagrams-transition states (general considerations). Grignard reagents: Preparation and synthetic applications. Alcohols: Comparative study of substitution, dehydration, oxidation, and esterification of primary, secondary and tertiary alcohols.

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UNIT V

Stereochemistry: Fischer, Saw-horse and Newman projection formulae, Chirality-optical activity, enantiomersim and diastereoisomerism involving one and two chiral centres. Configuration; D/L, erythrose, threose and R/S nomenclatures. Geometrical isomerism and E/Z nomenclatures. Conformations of n-butane. Active methylene compounds: Preparation and synthetic applications of ethyl acetoacetate and diethyl malonate, Tautomerism

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Year I, Semester I, Paper-2 (Practical)

Course Code:	BCH1171	Credits
Course Title:	Quantitative Analysis	2

Subject: Elective:

Max. Marks: 30+70

Total No. of Lectures: 60

Unit I

Water Quality Analysis:

1. Estimation of Hardness of water by EDTA
2. Determination of Chemical Oxygen Demand
3. Determination of Biological Oxygen Demand

Unit II

4. Estimation of Ferrous and Ferric by dichromate method
5. Estimation of Copper using thiosulphate

Unit III

Detection of elements (X, N, S).

Detection of functional groups: PhOH, -COOH, C=O, -CHO, Ar-NH₂, Ar-NO₂, -CONH₂

Qualitative Inorganic Mixture Analysis: Anions and interfering anions.

Unit IV

Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture

Estimation of calcium content in chalk as calcium oxalate by permagnometry

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Year I, Semester II, Paper-1 (Theory)

Course Code:	BCH1201	Credits
Course Title:	Inorganic and Physical Chemistry	4

Subject: Elective:

Max. Marks: 30+70

Total No. of Lectures: 60

Course Objective

CO1	To demonstrate theoretical knowledge of fundamentals of Chemistry in understanding Chemical Kinetics.
CO2	To gain an understanding of the Spectroscopic techniques and their Applications.
CO3	To understand the Coordination complexes and their applicability.
CO4	To understand the concepts of liquid crystals and their applications.
CO5	To familiarize the concepts of Inorganic Spectroscopic techniques.

Unit 1

Periodic trends and properties: Size, Ionization Energy, Electron Affinity, Electronegativity, Lattice and Hydration Energies, Use of redox potential and reaction feasibility. Chemistry of s and p-block elements: Alkali and alkaline earth metals: Hydrides and Complexation tendencies. Structural features of hydrides, halides, oxides and oxyacids. Chemistry of d-block elements: Salient features, characteristic properties of 3d-elements with reference to oxidation states, colour, magnetic behaviour, and complex formation tendency.

Unit 1

Gaseous State: Kinetic theory of gases, ideal gas laws based on kinetic theory. Collision in a gas- mean free path, collision diameter, collision number. Behaviour of real gases - the van der Waal's equation. Critical phenomena - critical constants of a gas and their determination, the van der Waals equation and critical state, Principle of corresponding states. **Liquid State:** Surface tension of liquids - capillary action, experimental determination of surface tension, temperature effect on surface tension. Viscosity of liquids, experimental determination of viscosity coefficient, its variation with temperature.

Thermodynamics: First Law of thermodynamics and internal energy, state and state functions, sign convention for heat and work, nature of work, path dependence of heat and work. Enthalpy, heat changes at constant volume and constant pressure, heat capacities (C_v , C_p) and their relationship for

ideal gases. Thermodynamic quantities (w , q , ΔU , ΔH) for isothermal and adiabatic reversible expansion of ideal gases and their comparison. Change in internal energy (ΔU) and enthalpy (ΔH) of chemical reactions, relation between ΔU and ΔH , variation of heat of reaction with temperature (Kirchhoff's equation).

Electrochemistry: Arrhenius theory of electrolytic dissociation, Hydrolysis of salts, hydrolysis constant, buffer solutions, indicators and theory of acid-base indicators. Migration of ions: transference number and its determination by Hittorf methods. Conductance of electrolyte solutions, molar conductance of electrolyte and its splitting into ionic molar conductance, Kohlrausch law of independent migration of ions, ionic mobility. Application of conductance measurements: determination of degree of dissociation and dissociation constant of weak electrolytes/acids, solubility of sparingly soluble salts, and Conductometric titrations.

Nuclear Chemistry: Nucleus and its classification, nuclear forces, nuclear binding energy, stability of nucleus. Radioactivity: Radioactive elements, general characteristics of radioactive decay, decay kinetics (decay constant, half life, mean life period), units of radioactivity.

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Year I, Semester II, Paper-2 (Practical)

Course Code:	BCH1271	Credits
Course Title:	Quantitative Analysis (Physical and Volumetric)	2

Subject: Elective:

Max. Marks: 30+70

Total No. of Lectures: 60

Course Objective

C01	To demonstrate theoretical knowledge of fundamentals of Chemistry in understanding Chemical Kinetics.
C02	To gain an understanding of the Spectroscopic techniques and their Applications.
C03	To understand the Coordination complexes and their applicability.
C04	To understand the concepts of liquid crystals and their applications.
C05	To familiarize the concepts of Inorganic Spectroscopic techniques.

Determination of water equivalent of a calorimeter (cooling curve). Heat of neutralization (strong acid-strong base). Heat of dissociation of weak acid. Heat of solution (NH_4NO_3 , CaCl_2). Basicity of an acid by thermochemical method.

Qualitative Inorganic Mixture Analysis: Not containing more than 4 ions and one interfering anion

Separation of Mixture

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Year II, Semester III, Paper-1 (Theory)

Course Code:	BCH2301	Credits
Course Title:	Chemical Dynamics and Coordination Chemistry	4

Subject: Elective:

Max. Marks: 30+70

Total No. of Lectures: 60

Course Objective

CO1	To demonstrate theoretical knowledge of fundamentals of Chemistry in understanding Chemical Kinetics.
CO2	To gain an understanding of the Spectroscopic techniques and their Applications.
CO3	To understand the Coordination complexes and their applicability.
CO4	To understand the concepts of liquid crystals and their applications.
CO5	To familiarize the concepts of Inorganic Spectroscopic techniques.

UNIT - I

Chemical Kinetics: Rate of a reaction, molecularity and order of reaction, concentration dependence of rates, zero order, first order, second order, half-life and mean life. Determination of the order of reaction- method of integration and half-life method. **Theories of chemical kinetics:** Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis).

UNIT – II

Chemical Equilibrium : Equilibrium constant and free energy, thermodynamic derivation of law of mass action. Le-Chatelier's principle. reaction isotherm and reaction isochore - ClapeyronClausius equation and its applications. **Liquid State:** Intermolecular forces, structure of liquids (a qualitative description). Structural differences between solids, liquids and gases. Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholesteric phases.

Liquids in solids (gels): Classification, preparation and properties, inhibition, general application.

UNIT – III

Coordination Chemistry: Werner's theory of coordination complexes, classification of ligands, ambidentate ligands, chelates, coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo isomerism, geometrical and optical isomerism in square planar and octahedral complexes.

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Theories of Coordination Chemistry: Metal-ligand bonding in transition metal complexes, limitations of valence bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planar complexes, Jahn Teller effect, factors affecting the crystal-field parameters.

Thermodynamic and kinetic aspects of metal complexes: A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, stability constants of complexes and their determination, substitution reactions of square planar complexes.

UNIT – IV

Inorganic Spectroscopy and Magnetism

Electronic spectra of Transition Metal Complexes: Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series, Orgel-energy level diagram for d1 and d9 states, discussion of the electronic spectrum of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ complex ion.

Magnetic properties of transition metal complexes, types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moments, application of magnetic moment data for 3d-metal complexes.

UNIT – V

Phase Equilibrium: Statement and meaning of the terms - phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system - water, CO_2 and sulphur systems.

Phase equilibria of two component systems - Solid-liquid equilibria, simple eutectic - Bi-Cd, Pb-Ag systems.

Suggested Readings:

- Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
- Cotton, F.A, Wilkinson, G and Gaus, P. L, Basic Inorganic Chemistry, 3rd Edition, Wiley 1995
- Lee, J.D, Concise Inorganic Chemistry 4th Edition ELBS, 1977
- Douglas, B, McDaniel, D and Alexander, J, Concepts of Models of Inorganic Chemistry, John Wiley & Sons; 3rd edition, 1994
- Shriver, D.E Atkins, P.W and Langford, C.H, Inorganic Chemistry, Oxford University Press, 1994.
- Porterfield, W.W, Inorganic Chemistry, Addison Wesley 1984.
- Sharpe, A.G, Inorganic Chemistry, ELBS, 3rd edition, 1993
- Miessler, G.L, Tarr, D.A, Inorganic Chemistry, 2nd edition, Prentice Hall, 2001

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Year II, Semester III, Paper-2 (Practical)

Course Code:	BCH2371	Credits
Course Title:	Physical Analysis	2

Subject: Elective:

Max. Marks: 30+70

Total No. of Lectures: 60

UNIT – I

Strengths of Solution

Calibration of fractional weights, pipettes and burettes. Preparation of standards solutions. Dilution – 0.1 M to 0.001 M solutions.

Mole Concept and Concentration Units: Mole Concept, molecular weight, formula weight, and equivalent weight.

Concentration units: Molarity, Formality, Normality, Molality, Mole fraction, Percent by weight, Percent by volume, Parts per thousand, Parts per million, Parts per billion, pH, pOH, milli equivalents, Milli moles.

UNIT II

Surface Tension and Viscosity

- Determination of surface tension of pure liquid or solution
- Determination of viscosity of liquid pure liquid or solution

UNIT III

Boiling point and Transition Temperature

- Boiling point of common organic liquid compounds [ANY FIVE] n-butylalcohol, cyclohexanol, ethyl methyl ketone, cyclohexanone, acetylacetone, isobutyl methyl ketone, isobutyl alcohol, acetonitrile, benzaldehyde and acetophenone. [Boiling points of the chosen organic compounds should preferably be within 180°C].
- Transition Temperature. Determination of the transition temperature of the given substance by thermometric/dilatometric method (e.g. $\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$ / $\text{SrBr}_2 \cdot 2\text{H}_2\text{O}$)

UNIT IV

To study the effect of a solute (e.g. NaCl, succinic acid) on the critical solution temperature of two partially miscible liquids (e.g. phenol-water system) and to determine the concentration of that solute in the given phenol-water system

- To construct the phase diagram of two component (e.g. diphenylamine – benzophenone) system by cooling curve method.

Suggested Readings:

- Skoog, D.A., West, D.M and Holler, F.J., "Analytical Chemistry: An Introduction", 7th edition. Saunders college publishing, Philadelphia, (2010).
- Larry Hargis, G. "Analytical Chemistry: Principles and Techniques" Pearson© (1988)

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Year II, Semester IV, Paper-1 (Theory)

Course Code:	BCH2401	Credits
	Quantum Mechanics, Spectroscopy and Analytical Techniques	4

Subject: Elective

Max. Marks: 30+70

Total No. of Lectures: 60

Course Objectives

CO1	To demonstrate theoretical knowledge of fundamentals of Chemistry in understanding Of Quantum Mechanics.
CO2	To gain an understanding of the Spectroscopic techniques and their Applications.
CO3	To understand the Separation Techniques and their applicability.
CO4	To understand the concepts of Molecular Spectroscopy.
CO5	To familiarize the concepts of Vibrational Spectroscopy.

UNIT - I

Quantum Mechanics: Wave particle Duality, Schrodinger equation, atomic Structure, Chemical Bonding. Uncertainty Principle. of Black-body radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (no derivation) and its defects, Compton effect, de-Broglie hypothesis.

UNIT – II

Spectroscopic techniques and Applications: IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; Hooke's law selection rule, IR absorption positions of various functional groups (C=O, OH, NH, COOH and nitrile) NMR Spectroscopy: introduction; nuclear spin; NMR active molecules; basic principles of Proton Magnetic Resonance; choice of solvent and internal standard; equivalent and non-equivalent protons; chemical shift and factors influencing it; ring current effect Elementary idea and simple applications of Ultraviolet & Visible and NMR Spectroscopy.

UNIT – III

Separation Techniques: Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media. **Chromatography:** Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods.

UNIT – IV

Molecular Spectroscopy: Introduction: Electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppenheimer approximation, degrees of freedom. **Rotational Spectrum:** Diatomic molecules. Energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotor, isotope effect.

UNIT – V

Vibrational Spectrum: Infrared spectrum: Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of

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anharmonic motion and isotope on the spectrum, idea of vibrational frequencies. **Raman spectrum:** Concept of polarizability, pure rotational and pure vibrational, Raman spectra of diatomic molecules, selection rules. **Electronic Spectrum:** Concept of potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules.

Suggested Readings:

- Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
- Cotton, F.A, Wilkinson, G and Gaus, P. L, Basic Inorganic Chemistry, 3rd Edition, Wiley 1995
- Lee, J.D, Concise Inorganic Chemistry 4th Edition ELBS, 1977
- Douglas, B, McDaniel, D and Alexander, J, Concepts of Models of Inorganic Chemistry, John Wiley & Sons; 3rd edition, 1994
- Shriver, D.E Atkins, P.W and Langford, C.H, Inorganic Chemistry, Oxford University Press, 1994.
- Porterfield, W.W, Inorganic Chemistry, Addison Wesley 1984.
- Sharpe, A.G, Inorganic Chemistry, ELBS, 3rd edition, 1993
- Miessler, G.L, Tarr, D.A, Inorganic Chemistry, 2nd edition, Prentice Hall, 2001

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Year II, Semester IV, Paper-2 (Practical)

Course Code:	BCH32471	Credits
	Instrumental Analysis	2

Subject: Elective

Max. Marks: 30+70

Total No. of Lectures: 60

UNIT I

Molecular Weight Determination

- Determination of molecular weight of a non-volatile solute by Rast method/Beckmann freezing point method.
- Determination of the apparent degree of dissociation of an electrolyte (e.g., NaCl) in aqueous solution at different concentrations by Ebullioscopy.

UNIT II

Spectrophotometry

- To verify Beer–Lambert Law for $\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$ and determining the concentration of the given solution of the substance from absorption measurement
- Determination of pKa values of indicator using spectrophotometry.
- Determination of COD and BOD.

UNIT III

Chromatographic Separations

- Paper chromatographic separation of following metal ions: i. Ni(II) and Co(II) ii. Cu(II) and Cd(II)
- Separation of a mixture of o- and p-nitrophenol or o- and p-aminophenol by thin layer Chromatography (TLC).

UNIT-IV

Separation and identification of the amino acids present in the given mixture by paper chromatography. Reporting the Rf values

- TLC separation of a mixture of dyes (fluorescein and methylene blue)

Suggested Readings:

- Skoog, D.A., West, D.M and Holler, F.J., "Analytical Chemistry: An Introduction", 7th edition. Saunders college publishing, Philadelphia, (2010).
- Larry Hargis, G. "Analytical Chemistry: Principles and Techniques" Pearson© (1988)

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Year III, Semester V, Chemistry Paper-I

Course Code:	BCH3501	Credits
	Organic Synthesis -I	4

Subject: Elective

Max. Marks: 30+70

Total No. of Lectures: 60

Course Objectives

CO1	To demonstrate theoretical knowledge of alkanes and alkenes.
CO2	To gain an understanding of the alkynes and basic concepts of aromaticity.
CO3	To understand the basic principles of arenes, chemistry of aromatic reactions.
CO4	To understand the reactions of alcohols and phenols.
CO5	To understand the concepts and reactions of ethers and organic halides.

UNIT - I

Chemistry of Alkanes and Cycloalkanes

A) Alkanes: Classification of carbon atom in alkanes, General methods of preparation, physical and chemical properties of alkanes: Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation - relative reactivity and selectivity

B) Cycloalkanes: Nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Chair, Boat and Twist boat forms of cyclohexane with energy diagrams, ring strain in small rings, theory of strain less rings. The case of cyclopropane ring, banana bonds.

Chemistry of Alkenes

Methods of formation of alkenes, Addition to $C=C$: mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity; reactions: hydrogenation, halogenation, hydrohalogenation, hydration, ozonolysis, addition of singlet and triplet carbenes; Simmons-Smith cyclopropanation reaction; electrophilic addition to diene (conjugated dienes and allene); radical addition: HBr addition; mechanism of allylic and benzylic bromination in competition with brominations across $C=C$; use of NBS; interconversion of E- and Z- alkenes.

UNIT - II

Chemistry of Alkynes

Methods of formation of alkynes, Addition to $C\equiv C$, mechanism, reactivity, regioselectivity and stereoselectivity; reactions: hydrogenation, halogenations, hydrohalogenation, hydration, oxymercuration demercuration, hydroboration-oxidation, dissolving metal reduction of alkynes (Birch); reactions of terminal alkynes by exploring its acidity; interconversion of terminal and non-terminal alkynes.

Aromaticity and Chemistry of Arenes

Nomenclature of benzene derivatives, MO picture of benzene, Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their Mechanism. Directing effects of the groups. Birch reduction, Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl, naphthalene and anthracene.

UNIT - III

Chemistry of Alcohols: Classification and nomenclature. Monohydric alcohols – nomenclature, methods of formation by reduction of Aldehydes, Ketones, Carboxylic acids and Esters, Hydrogen bonding, Acidic nature, Reactions of alcohols.

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Dihydric alcohols nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$\text{Pb}(\text{OAc})_4$ and HIO_4] and pinacol pinacolone rearrangement.

Trihydric alcohols - nomenclature, methods of formation, chemical reactions of glycerol.

UNIT – IV

Chemistry of Phenols: Nomenclature, structure and bonding, preparation of phenols, physical properties and acidic character, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols – electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction.

UNIT – V

Chemistry of Ethers and Epoxides: Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions – cleavage and autoxidation, Ziesel's method. Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.

Chemistry of Organic Halides

Nomenclature and classes of alkyl halides, methods of formation, chemical reactions, Mechanisms of nucleophilic substitution reactions of alkyl halides, $\text{S}_\text{N}2$ and $\text{S}_\text{N}1$ reactions with energy profile diagrams; Polyhalogen compounds: Chloroform, carbon tetrachloride; Methods of formation of aryl halides, nuclear and side chain reactions; The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions; Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides, Synthesis and uses of DDT and BHC.

Suggested Readings:

- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003.
- Carey, F. A., Giuliano, R. M. Organic Chemistry, Eighth edition, McGraw Hill Education, 2012.
- Loudon, G. M. Organic Chemistry, Fourth edition, Oxford University Press, 2008.
- Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, 2nd edition, Oxford University Press, 2012.
- Graham Solomons, T.W., Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc.
- Smith, J. G. Organic Chemistry, Tata McGraw-Hill Publishing Company Limited.
- March, J. Advanced Organic Chemistry, Fourth edition, Wiley.
- Bariyar and Goyal, Organic Chemistry-II, Krishna Prakashan Media, Meerut, Third Edition, 2019

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Year III, Semester V, Chemistry Paper-2 (Theory)

Course Code:	BCH3502	Credits
	Rearrangements and Chemistry of Group Elements	4

Subject: Major Core Course

Max. Marks: 25+75

Total No. of Lectures: 60

Course Objectives

CO1	To demonstrate theoretical knowledge of Rearrangements.
CO2	To gain an understanding of the importance of Catalysis in Chemical reactions.
CO3	To understand the basic principles of s and p blocks.
CO4	To understand the basic concepts related to Lanthanides and Actinides.
CO5	To understand the concepts and reactions of Bioinorganic Chemistry.

UNIT I

Rearrangements: A detailed study of the following rearrangements: Pinacol-pinacolone, Demjanov, Benzil-Benzilic acid, Favorskii, Hofman, Curtius, Schmidt, Baeyer-Villiger and Fries rearrangement. **Catalysis:** General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts. Phase transfer catalysts, application of zeolites as catalysts. Enzyme catalysis; Michaelis-Menten equation, turn-over number.

UNIT-II

s-Block Elements: Comparative study, diagonal relationship, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, an introduction to alkyls and aryls. **p-Block Elements:** Comparative study (including diagonal relationship) of groups 13-17 elements, compounds like hydrides, oxides, oxyacids and halides of group 13-16, hydrides of boron-diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), tetrasulphur tetra nitride, basic properties of halogens, interhalogens and polyhalides. **Chemistry of Noble Gases:** Chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon compounds.

UNIT-III

Chemistry of Transition Elements: Chemistry of Elements of First Transition Series - Characteristic properties of d-block elements. Binary compounds (hydrides, carbides and oxides) of the elements of the first transition series and complexes with respect to relative stability of their oxidation states, coordination number and geometry. **Chemistry of Elements of Second and Third Transition Series** - General characteristics, comparative treatment of Zr/Hf, Nb/Ta, Mo/W in respect of ionic radii, oxidation states, magnetic behavior, spectral properties and stereochemistry.

UNIT-IV

Chemistry of Lanthanides: Electronic structure, oxidation states and ionic radii and lanthanide contraction, occurrence and isolation, ceric ammonium sulphate and its analytical uses, complex formation. **Chemistry of Actinides:** Electronic configuration, oxidation states and magnetic properties, chemistry of separation of Np, Pu and Am from U.

UNIT-V

Metal Carbonyls: Metal carbonyls: 18-electron rule, preparation, structure and nature of bonding in the mononuclear and dinuclear carbonyls.: **Bioinorganic Chemistry** Essential and trace elements in biological processes, metalloporphyrins with

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special reference to hemoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to Ca^{2+} . Nitrogen fixation.

Suggested Readings:

- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003.
- Carey, F. A., Giuliano, R. M. Organic Chemistry, Eighth edition, McGraw Hill Education, 2012.
- Loudon, G. M. Organic Chemistry, Fourth edition, Oxford University Press, 2008.
- Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, 2nd edition, Oxford University Press, 2012.
- Graham Solomons, T.W., Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc.
- Smith, J. G. Organic Chemistry, Tata McGraw-Hill Publishing Company Limited.
- March, J. Advanced Organic Chemistry, Fourth edition, Wiley.
- Bariyar and Goyal, Organic Chemistry-II, Krishna Prakashan Media, Meerut, Third Edition, 2019

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Year III, Semester V, Chemistry Paper-3 (Practical)

Course Code:	BCH3571	Credits
	Qualitative Analysis	2

Subject: Major Core Course

Max. Marks: 30+70

Total No. of Lectures: 60

COURSE OBJECTIVES

CO1	To gain expertise in Inorganic qualitative analysis.
CO2	To gain knowledge in identifying organic compounds.
CO3	To develop skills in separating the organic mixture.
CO4	To develop basic skills required for analysis of the elements.
CO5	To gain practical knowledge in the identification of the functional groups.

UNIT I

Inorganic Qualitative Analysis

Semi micro Analysis – cation analysis, separation and identification of ions from Groups I, II, III, IV, V and VI, Anion analysis. Mixture containing 6 radicals - 2+4 or 4+ or 3+3

UNIT II

Identification of organic compounds

Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives.

UNIT III

Separation of Organic Mixture

Analysis of an organic mixture containing two solid components using water, NaHCO_3

UNIT IV

Elemental analysis and identification of functional groups

Detection of extra elements (N, S and halogens) and functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide) in simple organic compounds.

Suggested Readings:

- Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
- Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

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- Harris, D.C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
- Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.

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Year III, Semester VI Chemistry Paper I (Theory)

Course Code:	BCH3601	Credits
	Organic Synthesis B	4

Max. Marks: 30+70

Total No of Lectures: 60

Course Outcome

CO1	This paper provides detailed knowledge of synthesis of various class of organic compounds and functional groups inter conversion. Organic synthesis is the most important branch of organic chemistry which provides jobs in production & QC departments related to chemicals, drugs, medicines, FMCG etc. industries.
CO2	The study of natural products and heterocyclic compounds offers an excellent strategy toward identifying novel biological probes for a number of diseases. Historically, natural products have played an important role in the development of pharmaceutical drugs for a number of diseases including cancer and infection.

Unit I

Reagents in Organic Synthesis: A detailed study of the following reagents in organic transformations Oxidation with DDQ, CAN and SeO₂, mCPBA, Jones Oxidation, PCC, PDC, PFC, Collin's reagent and ruthenium tetroxide. Reduction with NaBH₄, LiAlH₄, Meerwein-Ponndorf-Verley (MPV) reduction, Wilkinson's catalyst, Birch reduction, DIBAL. **Organometallic Compounds** - Organomagnesium compounds: the Grignard reagents, formation, structure and chemical reactions. Organozinc compounds: formation and chemical reactions. Organolithium compounds: formation and chemical reactions.

Unit II

Chemistry of Aldehydes and ketones: Nomenclature and structure of the carbonyl groups, synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones uses 1,3-dithianes, synthesis of ketones from nitrites and from carboxylic acids, Physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations, Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Oxidation of aldehydes, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, LiAlH₄ and NaBH₄ reductions. Halogenation of enolizable ketones An introduction to α , β unsaturated aldehydes and Ketones.

Unit III

Carboxylic acids and their Functional Derivatives: Nomenclature and classification of aliphatic and aromatic carboxylic acids. Preparation and reactions, Acidity (effect of substituents on acidity) and salt formation, Reactions: Mechanism of reduction, substitution in alkyl or aryl group. Preparation and properties of dicarboxylic acids such as oxalic, malonic, succinic, glutaric, adipic and phthalic acids and unsaturated carboxylic acids such as acrylic, crotonic and cinnamic acids, Reactions: Action of heat on hydroxy and amino acids, and saturated dicarboxylic acids, stereospecific addition to maleic and fumaric acids. Preparation and reactions of acid chlorides, acid anhydrides, amides and esters, acid and alkaline hydrolysis of esters, trans-esterification.

Unit IV

Heterocyclic Chemistry: Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine, Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution, Mechanism of nucleophilic substitution reaction in pyridine derivatives, Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and six membered heterocycles, Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Nepieralski synthesis, Mechanism of electrophile substitution reactions of indole, quinoline and isoquinoline **Natural Products Alkaloids &**

Terpenes: Natural occurrence, General structural features, their physiological action, Hoffmann's exhaustive methylation, Emde's modification. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine. Natural Occurrence and classification of terpenes, isoprene rule.

Unit V

Organic Compounds of Nitrogen: Preparation of nitroalkanes and nitroarenes, Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media, Picric acid. Halonitroarenes: reactivity, Structure and nomenclature of amines, physical properties, Stereochemistry of amines, Separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines. Amine salts as phase-transfer catalysts, Preparation of alkyl and aryl amines (reduction of nitro compounds, nitrites), reductive amination of aldehydic and ketonic compounds, Gabrielphthalimide reaction, Hofmann bromamide reaction. Reactions of amines, electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling

Suggested Readings:

- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003.
- Carey, F. A., Giuliano, R. M. Organic Chemistry, Eighth edition, McGraw Hill Education, 2012.
- Loudon, G. M. Organic Chemistry, Fourth edition, Oxford University Press, 2008.
- Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, 2nd edition, Oxford University Press, 2012.
- Graham Solomons, T.W., Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc.
- Smith, J. G. Organic Chemistry, Tata McGraw-Hill Publishing Company Limited.
- March, J. Advanced Organic Chemistry, Fourth edition, Wiley
- Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly & Sons (1976).
- Finar, I.L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I.L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
- Singh, J., Ali, S.M. & Singh, J. Natural Product Chemistry, Pragati Prakashan (2010)
- Organic Chemistry III, Krishna Prakashan Media, Meerut, Third Edition, 2019

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Year III, Semester VI Chemistry Paper-2 (Theory)

Course Code:	BCH3602	Credits
	Chemical Energetics and Radio Chemistry	4

Max. Marks: 30+70

Total No of Lectures: 60

Course Outcome

CO1	Upon successful completion of this course students should be able to describe laws of thermodynamics and its applications, phase equilibria of one and two component system, electrochemistry, ionic equilibrium applications of conductivity and potentiometric measurements
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UNIT – I

Thermodynamics-1: First Law of Thermodynamics: Statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law – Joule-Thomson coefficient and inversion temperature. Calculation of w , q , dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process. **Thermochemistry:** Standard state, standard enthalpy of formation – Hess's law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization. Bond dissociation energy and its calculation from thermo-chemical data, temperature dependence of enthalpy. Kirchhoff's equation.

UNIT – II

Thermodynamics II: Second Law of Thermodynamics, Need for the law, different statements of the law, Carnot cycle and its efficiency. Carnot theorem. Thermodynamic scale of temperature. Concept of Entropy, Entropy as a state function, entropy as a function of V & T , entropy as a function of P & T , entropy change in physical change, Clausius inequality, entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases. Gibbs and Helmholtz Functions Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities. A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, Variation of G and A with P , V and T . Third Law of Thermodynamics; Nernst heat theorem, statement and concept of residual entropy. Nernst distribution law – Thermodynamic derivation, applications.

UNIT – III

Electrochemistry: Electrical transport: Conduction in metals and in electrolyte solutions, specific conductance, molar and equivalent conductance, measurement of equivalent conductance, variation of molar, equivalent and specific conductances with dilution. Migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations. Weak and strong electrolytes. Ostwald's dilution law, its uses and limitations. Debye-Huckel-Onsager equation for strong electrolytes (elementary treatment only). Transport number, definition and determination by Hittorf method and moving boundary method.

UNIT – IV

Photo Chemistry: Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grothus-Draper law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions – energy transfer processes (simple examples), kinetics of photochemical reaction.

UNIT – V

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Radiochemistry: Natural and induced radioactivity; radioactive decay - α -decay, β -decay, γ -decay; neutron emission, positron emission, electron capture; unit of radioactivity (Curie); half life period; Geiger-Nuttall rule, radioactive displacement law, radioactive series. Measurement of radioactivity: ionization chamber, Geiger counters, scintillation counters. Applications: energy tapping, dating of objects, neutron activation analysis, isotopic labelling studies, nuclear medicine - ^{99m}Tc radiopharmaceuticals

Suggested Readings:

- Foye, W.O., Lemke, T.L. & William, D.A.: Principles of Medicinal Chemistry, 4th ed., B.I. Waverly Pvt. Ltd. New Delhi.
- Peter Atkins & Julio De Paula, Physical Chemistry 9th Ed., Oxford University Press (2010).
- Metz, C.R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).
- Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Castellan, G. W. Physical Chemistry 4th Edn. Narosa (2004).
- Allen Bard, J Larry, Faulkner R, Fundamentals of Electrochemical methods – fundamentals and applications, new York John, Wiley & sons, 2001
- H.J. Arnikar, Essentials of Nuclear Chemistry, 4th ed., New Age International, New Delhi, 1995.
- Bariyar and Goyal, Physical Chemistry-II, Krishna Prakashan Media, Meerut, Third Edition, 2019

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Year III, Semester VI Chemistry Paper-3 (Practical)

Course Code:	BCH3671	Credits
	Analytical Methods	2

Max. Marks: 30+70

Total No of Lectures: 60

Course Outcome

CO1	Upon successful completion of this course students should be able to describe laws of thermodynamics and its applications, phase equilibria of one and two component system, electrochemistry, ionic equilibrium applications of conductivity and potentiometric measurements
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UNIT-1

Gravimetric Analysis

1. Analysis of Cu as CuSCN,
2. Analysis of Ni as Ni (dimethylgloxime)
3. Analysis of Ba as BaSO₄.

UNIT-1

Paper Chromatography

Ascending and Circular. Determination of R_f values and identification of organic compounds, Separation of a mixture

Unit-3

Thin Layer Chromatography

Determination of R_f values and identification of organic compounds: Separation of green leaf pigments (spinach leaves may be used)

Unit 4

Thermochemistry

1. To determine the solubility of benzoic acid at different temperatures and to determine ΔH of the dissolution process
2. To determine the enthalpy of neutralization of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionization of the weak acid/weak base

Suggested Readings:

1. Skoog .D.A., West.D.M and Holler .F.J., "Analytical Chemistry: An Introduction", 7th edition, Saunders college publishing, Philadelphia,(2010).
2. Larry Hargis.G" Analytical Chemistry: Principles and Techniques" Pearson©(1988)
3. 4. <https://www.labster.com/chemistry-virtual-labs/> 5. <https://www.vlab.co.in/broad-area-chemical-sciences> 6. <http://chemcollective.org/vlabs>

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National Education Policy-2020

PROPOSED STRUCTURE OF SYLLABUS

Vocational Courses



(FACULTY OF SCIENCE)

FUTURE UNIVERSITY, BAREILLY

18th Milestone, Bareilly-Lucknow Highway NH-24

Near Faridpur, Bareilly, Uttar Pradesh 243503

Website: www.futureuniversity.in




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Vocational course: Semester-1
Course Title: Vyavharik Hindi

Programme/Class:	B.Sc.
Year:	First
Semester:	First
Vocational Course	
Course Code: VOC0001	Course Title: Vyavharik Hindi

Course outcomes:

- CO1 विद्यार्थी हिंदी भाषा एवं उसकी व्याकरणिक संरचना (वर्ण, शब्द, वाक्य) की मूल समझ विकसित कर सकेंगे।
CO2 विद्यार्थी शुद्ध एवं प्रभावी हिंदी लेखन (वर्तनी, वाक्य रचना) कर सकेंगे।
CO3 विद्यार्थी औपचारिक व अनौपचारिक पत्र, आवेदन पत्र तथा बायोडाटा का प्रारूप तैयार कर सकेंगे।
CO4 विद्यार्थी प्रतिवेदन, सारांश एवं अनुवाद जैसे प्रारूपिक लेखन-कौशल में दक्षता प्राप्त कर सकेंगे।
CO5 विद्यार्थी साक्षात्कार, प्रस्तुतिकरण व समूह चर्चा हेतु मौखिक संप्रेषण कौशल तथा व्यावसायिक हिंदी शब्दावली का उपयोग कर सकेंगे।

Credits: 2 Compulsory

Max. Marks: 100 Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 2-0-0

Unit	Topic	No. of Lectures
I	हिंदी भाषा एवं व्याकरण की मूल संरचना - हिंदी भाषा — उद्भव, विकास एवं स्वरूप - वर्ण विचार — स्वर एवं व्यंजन, उच्चारण स्थान - शब्द रचना — उपसर्ग, प्रत्यय - संधि एवं समास (परिभाषा, भेद, उदाहरण) - वर्तनी संबंधी सामान्य अशुद्धियाँ एवं शुद्धिकरण	
II	व्यावहारिक व्याकरण एवं शब्द भंडार (लिंग, वचन एवं कारक - मुहावरे एवं लोकोक्तियाँ - पर्यायवाची तथा विलोम शब्द - अनेकार्थी शब्द एवं शब्द-युग्म - वाक्य रचना के सिद्धांत एवं वाक्य शुद्धिकरण	

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Unit	Topic	No. of Lectures
III	पत्र लेखन एवं आवेदन-पत्र 1. औपचारिक एवं अनौपचारिक पत्र लेखन 2. कार्यालयीन पत्र — अवकाश हेतु आवेदन, शिकायत पत्र 3. नौकरी हेतु आवेदन-पत्र लेखन 4. बायोडाटा (Resume) तैयार करना 5. ई-मेल लेखन के व्यावहारिक नियम	
IV	संप्रेषण कौशल एवं व्यावसायिक हिंदी 1. मौखिक संप्रेषण — आत्म-परिचय एवं साक्षात्कार की तैयारी 2. प्रस्तुतिकरण (Presentation) कौशल 3. समूह चर्चा एवं वाद-विवाद कौशल 4. व्यावसायिक हिंदी शब्दावली — बैंकिंग, कार्यालय, तकनीकी क्षेत्र 5. दूरभाष/टेलीफोनिक संवाद के शिष्टाचार एवं भाषा प्रयोग	

Suggested Readings:

- Singh, Anita, "Food and Nutrition", Star Publication, Agra, India, 2018.
- 1000Days-Nutrition_Brief_Brain-Think_Babies_FINAL.pdf
- <https://pediatrics.aappublications.org/content/141/2/e20173716>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5750909/>
- Sheel Sharma, Nutrition and Diet Therapy, Peepee Publishers Delhi, 2014, First Edition.

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Vocational course: Semester-2
Course Title: Computer Application

Vocational course

Programme/Class:	B.Sc.
Year:	First
Semester:	Second
Vocational Course	
Course Code: VOC0002	Course Title: Computer Application

Course outcomes:

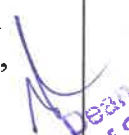
- CO1 Understand the basic concepts of computer, its characteristics, and hardware/software components.
- CO2 Operate the Windows operating system and perform basic file and folder management operations.
- CO3 Create, edit and format documents using MS Word for personal and professional use.
- CO4 Prepare spreadsheets, apply formulas/functions and represent data using charts in MS Excel.
- CO5 Use the Internet and e-mail services effectively, and create basic presentations using MS PowerPoint.

Credits: Qualifying Compulsory

Max. Marks: 100 Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-0

Unit	Topic	No. of Lectures
I	Unit 1: Introduction to Computers 1. Computer — definition, characteristics and applications 2. Generations of computers 3. Classification of computers (based on size and purpose) 4. Hardware and Software — types of software (System, Application, Utility) 5. Input and Output devices 6. Memory — Primary memory (RAM, ROM) and Secondary memory (Hard Disk, Pen Drive, etc.) 7. Basics of number system (Binary, Decimal — introductory level)	
II	Unit 2: Operating System and Windows 1. Operating System — definition, functions and types 2. Introduction to Windows OS — Desktop, Icons, Taskbar, Start Menu 3. File and Folder management — creating, renaming, copying, moving, deleting 4. Introduction to Control Panel and system settings	


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Unit	Topic	No. of Lectures
	Introduction to Disk management (formatting, disk cleanup — basic level)	
III	Unit 3: MS Word (Word Processing) 1. Introduction to word processing software 2. Creating, saving and opening a document 3. Formatting text — font, size, style, alignment 4. Paragraph formatting, bullets and numbering 5. Working with Tables, Headers and Footers 6. Inserting images, page setup and printing 7. Introduction to Mail Merge	
IV	Unit 5: Internet and MS PowerPoint 1. Internet — introduction, uses and web browsers 2. Search engines and basics of web browsing 3. E-mail — creating an account, sending/receiving mails, attachments 4. Introduction to Presentation software (MS PowerPoint) 5. Creating slides, applying themes and templates 6. Inserting text, images and basic animations 7. Slide show and presentation delivery basics	

Suggested Readings:

1. Sinha, P.K. & Sinha, Priti. *Computer Fundamentals*. BPB Publications.
2. Rajaraman, V. *Fundamentals of Computers*. PHI Learning.
3. Peter Norton. *Introduction to Computers*. McGraw Hill Education.
4. Saxena, Sanjay. *MS Office 2016 (Word, Excel, PowerPoint) — A Practical Approach*. Vikas Publishing House.
5. ITL Education Solutions Limited. *Introduction to Information Technology*. Pearson Education.
6. Leon, Alexis & Leon, Mathews. *Fundamentals of Information Technology*. Vikas Publishing House.
7. Microsoft Official Documentation — Word, Excel, PowerPoint (support.microsoft.com)

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Vocational course: Semester-3
Course Title: Functional English

Syllabus: Functional English

Programme/Class: B.Sc.	Year: Second	Semester: Third
Vocational Course		
Course Code: VCC0003	Course Title: Functional English	
Course outcomes:		
• To develop an understanding of language functions in the students. • To employ Listening, Speaking, Reading, and Writing skills to the optimum in informal and formal settings. • To enhance speaking and writing skills and enable the students to develop power of communication through composition and conversational skills.		
Credits: 2		
Max. Marks: 100	Min. Passing Marks: 40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 2-0-0		

Unit	Topics	No. of Lectures Total=30
I	Developing Conversational Ability a) Greetings and Introduction b) Participating in small talks- At the office, At the railway station, At the airport, At the travel agency, At the bank, At the doctor's clinic, At the hospital. c) Talking on the telephone. d) Socializing- Making requests, expressing thanks & responding to thanks; Expressing likes and dislikes, offering Apology & making Requests. Offering help, complimenting and congratulating, refusing.	
II	Listening Comprehension Basic skills of listening, Listening Models, Body Language, Avoiding the barriers to listening, Streamlining of soundshape	
III	Applied Reading Applied Reading Strategies: Skimming, scanning, making inferences, recognizing patterns. Identifying the main ideas & supporting Details of a reading passage and paraphrasing/summarizing them. • Active Reading Strategies: Using Text Structure • Transitions • Identifying Relationships Among Ideas • Critical Reading Strategies: Evaluating Fact or Opinion, feelings, Author's Point of View and Purpose	
IV	Developing Writing a) Profile writing.	

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	b) Writing Formal letters: inviting people, making enquiries, complaining, asking for permission, making requests. c) Writing Job Applications. d) Writing product description. e) Argumentative Essay	
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Suggested Readings:

- J.Charles Alderson. 2000. Assessing Reading. CUP.
- William Grabe.2009. Reading in a second language : moving from Theory and Practice. CUP.
- Enid Nolan Woods & David Foll. 1986. Penguin Advanced Reading skills. Penguin.
- Donne Byrne.1998. Teaching Writing Skills. Longman Handbook for English Teachers. Longman Publishing House.
- Sara Freeman.Written Communication in English. Ron White & Valerie Arndt. 1991.
- Zinkin Taya. 1988. Write Right. A guide to effective communication in English. Prentice Hall of India. New Delhi.
- Moon, R., (2000) The Power of Extraordinary Listening, Zanshin Press, California, USA.
- Bhasker, W.W.S. and Prabhu, N.S. (1975) English Through Reading, MacMillan India Ltd.
- Greg S. Baker. 2011. Fitly Spoken: Developing Effective Communication and Social Skills. Brighton Publishing LLC.
- Casey Malarcher. 2018. Developing Listening Skills. Compass Publishing.

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Vocational course: Semester-4
Course Title: Organic Farming

Syllabus: Organic Farming

Programme: B.Sc.	Year: Second	Semester: Forth
Co-Curricular Course		
Course Code: BVC0004	Course Title: Organic Farming	
Course outcomes:		
1. Explain the concepts and principles of organic farming		
2. Demonstrate on the preparation and use of organic inputs 3. describe the role of microbes through bio-fertilizer on plant growth promotion		
3.demonstrate hands on experience on preparation of biofertilizers, bio-control agents and other natural sources of plant nutrition		
4. Explain the post-harvest aspects of organic animal products.		
5. examine marketing and economic potential of organic products		
Credits: 2	Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 2-0-0		

Unit	Topics	No. of Lectures Total=30
I	Organic farming, concept, principles and its scope in India and NE region; prospects and constraints of organic farming in India and NE region; Organic vs conventional farming; Traditional knowledge on organic management; Organic management of soilsources of plant nutrients, préparation and uses of different types of composts, FYM, vermicompost, green manures, oil cakes, bio-fertilizers etc	
II	- Organic management of pests, diseases and weeds: biological control of pests; biopesticides; cultural methods, crop rotation, mixed farming, trap cropping, companion cropping, smothering crops, bait traps, light traps, bird purchase etc.; - Trichoderma mass multiplication technique; soil solarization- types, methods and advantages; - Indigenous formulations for disease and pest management. Bio-pesticides. - Cultural and biological weed control methods. - Role of natural farming components on soil fertility and crop pest management.	Dear Faculty of Sciences Future University Bareilly [Signature]
III	Aspects of Organic milk, fish, eggs and meat production; Initiatives taken by the central Govt., state governments, NGOs and other organizations like APEDA for promotion of organic agriculture in India; Post harvest management of organic products- Processing, labelling,	[Signature]

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	storage and transport; Economic considerations and viability, marketing and export potential of organic products.; Operational structure of NPOP; Certification process and standards of organic farming	
IV	• Quality analysis of different bio-fertilizers. Methods of bio-fertilizer application. • Enrichment of FYM/compost/vermicompost. • Visit to the bio-fertilizer production plants. • Case studies of Indigenous Technical knowledge (ITK) for nutrient, insect, pest, disease and weed management. Economic analysis of organic production system.	

Suggested Readings:

1. Chandra S, Narayan S, Narayan R, Kumar A and Wani JA. 2023. Natural Farming a rising concept. Satish serial publishing house, New Delhi.
2. Organic Horticulture; Principles, Practices and Technologies, Westville, New Delhi.
3. Palaniappan SP and Annadurai K 2006. Organic Farming: Theory and Practices. Scientific Publishers, Jodhpur, India
4. Gehlot G. 2005. Organic farming; standards, accreditation certification and inspection. Agrobios, India.
5. 2. Lacal CT. 2018. Marketing of organic food produce. Delve publishing, Canada. Organic Horticulture; Principles, Practices and Technologies, Westville, New Delhi.
6. 2. Palaniappan SP and Annadurai K 2006. Organic Farming: Theory and Practices. Scientific Publishers, Jodhpur, India.
7. 3. Panda SC 2011. Organic Farming for sustainable agriculture. Kalyani Publishers, Jalandhar.

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Co-curricular course: Semester-5
Course Title: Vermicomposting

Co-Curricular Course name: Vermicomposting

Programme/Class:	Bachelor of Science
Year:	Third
Semester:	Fifth
Subject: Co-Curricular Course	
Course Code: VOC0005	Course Title: Vermicomposting

Course outcomes (Analytic Ability):

- CO 1: Familiarize with analogy, number system, set theory and its applications, number system and puzzles.
- CO 2: To understand the basics of Syllogism, figure problems, critical and analytical reasoning.
- CO 3: Familiarize with word processing application and worksheet.
- CO 4: To understand the basics of web surfing and cyber security.

Credits: 2 Co-Curricular

Max. Marks: 100 Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): 2-0-0

Unit	Topic	No. of Lectures
I	Earthworms Introduction of earthworms, Classification of earthworms and their types. The behavior of earthworms as indicators of soil fertility, as plant growth promoters & soil health regulators. Role of Earthworms to protect Environment.	
II	Vermicomposting Vermiculture and Vermicomposting, Advantages of Vermicomposting, Chemical composition of vermicompost. Vermicomposting in everyday life earthworms and vermicomposting at commercial scale. Vermicomposting and Sustainable agriculture, restoration of degraded soil systems, vermicomposting and its effect on the greenhouse effect. Vermicomposting and its economic viability.	
III	Integrated Farming, including vermiculture Eco-friendly farming system technology, Criteria for ecological and appropriate technologies in agro-forestry, natural-management and planted forests (ranching, farmers' perception to organic Farming and case studies).	
IV	Vermiculture and Vermicomposting material Farm waste and its vermicomposting materials, types of vermicomposting (indoor and outdoor), requirements of vermicomposting bedding materials Selection of suitable and dominant earthworm species: Composting materials;	

Unit	Topic	No. of Lectures
	Production of vermicompost harvesting the compost and worm; vermicompost applications, predators, pathogens, and parasites of earthworms.	

Suggested Readings:

1. Biology and Ecology of Tropical Earthworms by Priya Shankar Chaudhari and S.M. Singh Discovery Publishing House Pvt. Ltd. New-Delhi.
2. Vermicomposting for Sustainable Agriculture by P.K. Gupta, Agrobios (India), Agro. House. Jodhpur. 342 or 2.
3. Earthworm Ecology by C.A. Edwards CRC Press U.S.A.
4. Soil Biodiversity Ecological Process and Landscaps Management by
5. P.S. Ramakrishnan. K.G. saxena, M.J. Sulift, K.S. Rao, R.K. Maikhuri, Oxford and IBH Publishing Co. RA Ltd. New Delhi.
6. Vermiculture Eco-technology: Bhawankar Earthworm Research Institiute (BERI) Pune.
7. The Biological Management of Tropical soil Fertility- by P.L. Woomer and M. J Sulift Pub. John wiley & sons, New-York. Busbane Singapore.
8. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.
9. Bhatnagar & Patla, 2007. Earthworm vermiculture and vermin-composting, Kalyani Publishers, New Delhi.
10. Jordan & Verma, 2009. Invertebrate Zoology, Chand & Company Ltd.

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Co-curricular course: Semester-6
Course Title: Web Designing Hardware and Networking

Programme: B.Sc.	Year: Third	Semester: Sixth
Co-Curricular Course		
Course Code: VOC0006	Course Title: Web Designing Hardware and Networking	
Course outcomes:		
• The course aims to provide exposure to problem-solving through programming. • It aims to train the student to the basic concepts of the C-programming language. • Students will learn to develop simple algorithms and flow charts to solve a problem. • Programming Proficiency: Develop basic programming skills and logical thinking through hands-on experience with a programming language. • Understanding Fundamental Concepts: Grasp the key principles of data structures and their importance in computer science. • Problem-Solving Skills: Enhance problem-solving skills by teaching students how to apply IT solutions to real-world problems.		
Credits: 2	Compulsory	
Max. Marks: 100	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 2-0-0		

Unit	Topics	No. of Lectures Total=30
I	Introduction: Introduction to Programming, Program Concept, Characteristics of Programming, Stages in Program Development, Algorithms, Flowcharts, Types of Programming Methodologies, Introduction to C Programming Basic Program Structure in C, Variables and Assignments, Input and Output, Selection and Repetition Statements.	
II	Computer Hardware Fundamentals 1. Introduction to computer hardware and PC components 2. Motherboard — components and specifications 3. CPU, RAM and types of storage devices (HDD, SSD) 4. Power Supply Unit (SMPS) 5. Cabinets and form factors	

	6. Ports and connectors (USB, HDMI, VGA, etc.) •	
III	Unit 3: Troubleshooting and Maintenance 1. Common hardware problems and their troubleshooting 2. Preventive maintenance of computer systems 3. Software troubleshooting — common OS issues 4. Backup and recovery — basic concepts • Antivirus and basic system security tools	
IV	Unit 4: Networking Fundamentals 1. Introduction to computer networks and their types (LAN, MAN, WAN) 2. Network topologies (Bus, Star, Ring, Mesh) 3. Networking devices — Hub, Switch, Router, Modem 4. OSI Model — introduction to seven layers 5. TCP/IP Model — introduction 6. Setting up a basic LAN 7. IP addressing basics (IPv4) 8. Wireless networking basics (Wi-Fi)	

Suggested Readings:

1. Meyers, Mike. *Mike Meyers' CompTIA A+ Guide to Managing and Troubleshooting PCs*. McGraw Hill Education.
2. Forouzan, Behrouz A. *Data Communications and Networking*. McGraw Hill Education.
3. Tanenbaum, Andrew S. & Wetherall, David J. *Computer Networks*. Pearson Education.
4. Dean, Tamara. *Network+ Guide to Networks*. Cengage Learning.
5. Sinha, P.K. & Sinha, Priti. *Computer Fundamentals*. BPB Publications.


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National Education Policy-2020

PROPOSED STRUCTURE OF SYLLABUS

Co-curricular Courses



(FACULTY OF SCIENCE)

FUTURE UNIVERSITY, BAREILLY

18th Milestone, Bareilly-Lucknow Highway NH-24

Near Faridpur, Bareilly, Uttar Pradesh 243503

Website: www.futureuniversity.in

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Co-curricular course: Semester-1
Course Title: Food, Nutrition and Hygiene

Programme/Class:	B.Sc.
Year:	First
Semester:	First
Co-Curricular Course	
Course Code: UCC0001	Course Title: Food, Nutrition and Hygiene

Course outcomes:

- To learn the basic concept of the Food and Nutrition
- To study the nutritive requirement during special conditions like pregnancy and lactation
- To learn meal planning
- To learn 100 days Nutrition Concept
- To study common health issues in the society
- To learn the special requirement of food during common illness

Credits: 2 Compulsory

Max. Marks: 40+60 Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 2-0-0

Unit	Topic	No. of Lectures
I	Concept of Food and Nutrition (a) Definition of Food, Nutrients, Nutrition, Health, balanced Diet (b) Types of Nutrition- Optimum Nutrition, under Nutrition, Over Nutrition (c) Meal planning- Concept and factors affecting Meal Planning (d) Food groups and functions of food	8
II	Nutrients: Macro and Micro RDA, Sources, Functions, Deficiency and excess of (a) Carbohydrate (b) Fats (c) Protein (d) Minerals Major: Calcium, Phosphorus, Sodium, Potassium Trace: Iron, Iodine, Fluorine, Zinc (e) Vitamins Water soluble vitamins: Vitamin B, C Fat soluble vitamins: Vitamin A, D, E, K (f) Water (g) Dietary Fibre	7
III	1000 days Nutrition (a) Concept, Requirement, Factors affecting growth of child (b) Prenatal Nutrition (0 - 280 days): Additional Nutrients' Requirement and risk factors during pregnancy (c) Breast / Formula Feeding (Birth – 6 months of age) Complementary and Early Diet (6 months – 2 years of age)	8
IV	Community Health Concept (a) Causes of common diseases prevalent in the society and Nutrition requirement in the following Diabetes, Hypertension (High Blood Pressure), Obesity, Constipation, Diarrhea, Typhoid (b) National and International Program and Policies for improving Dietary Nutrition	

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Unit	Topic	No. of Lectures
	(c) Immunity Boosting Food	

Suggested Readings:

- Singh, Anita, "Food and Nutrition", Star Publication, Agra, India, 2018.
- 1000Days-Nutrition_Brief_Brain-Think_Babies_FINAL.pdf
- <https://pediatrics.aappublications.org/content/141/2/e20173716>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5750909/>
- Sheel Sharma, Nutrition and Diet Therapy, Peepee Publishers Delhi, 2014, First Edition.

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Co-curricular course: Semester-2
Course Title: First Aid and Health

Co-curricular course

Programme/Class:	B.Sc.
Year:	First
Semester:	Second
Co-Curricular Course	
Course Code: UCC0002	Course Title: First Aid and First Aid and Health

Course outcomes:

- Learn the skill needed to assess the ill or injured person.
- Learn the skills to provide CPR to infants, children and adults.
- Learn the skills to handle emergency child birth
- Learn the Basic sex education help young people navigate thorny questions responsibly and with confidence.
- Learn the Basic sex education help youth to understand Sex is normal. It's a deep, powerful instinct at the core of our survival as a species. Sexual desire is a healthy drive.
- Help to understand natural changes of adolescence
- Learn the skill to identify Mental Health status and Psychological First Aid

Credits: Qualifying Compulsory
Max. Marks: 40+60 Min. Passing Marks: 35
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-0

Unit	Topic	No. of Lectures
I	A. Basic First Aid Aims of first aid & First aid and the law. Dealing with an emergency, Resuscitation (basic CPR). Recovery position, Initial top to toe assessment. Hand washing and Hygiene Types and Content of a First aid Kit B. First AID Technique Dressings and Bandages. Fast evacuation techniques (single rescuer). Transport techniques. C. First aid related with respiratory system Basics of Respiration. No breathing or difficult breathing, Drowning, Choking, Strangulation and hanging, Swelling within the throat, Suffocation by smoke or gases and Asthma. D. First aid related with Heart, Blood and Circulation Basics of The heart and the blood circulation. Chest discomfort, bleeding. D. First aid related with Wounds and Injuries Type of wounds, Small cuts and abrasions Head, Chest, Abdominal injuries Amputation, Crush injuries, Shock E. First aid related with Bones, Joints Muscle related injuries Basics of The skeleton, Joints and Muscles. Fractures (injuries to bones).	


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Unit	Topic	No. of Lectures
II	F. First aid related with Nervous system and Unconsciousness Basics of the nervous system. Unconsciousness, Stroke, Fits – convulsions – seizures, Epilepsy. G. First aid related with Gastrointestinal Tract Basics of The gastrointestinal system. Diarrhea, Food poisoning. H. First aid related with Skin, Burns Basics of The skin. Burn wounds, Dry burns and scalds (burns from fire, heat and steam). Electrical and Chemical burns, Sun burns, heat exhaustion and heatstroke. Frost bites (cold burns), Prevention of burns, Fever and Hypothermia. I. First aid related with Poisoning Poisoning by swallowing, Gases, Injection, Skin J. First aid related with Bites and Stings Animal bites, Snake bites, Insect stings and bites K. First aid related with Sense organs Basic of Sense organ. Foreign objects in the eye, ear, nose or skin. Swallowed foreign objects. L. Specific emergency satiation and disaster management Emergencies at educational institutes and work Road and traffic accidents. Emergencies in rural areas. Disasters and multiple casualty accidents. Triage. M. Emergency Child birth	
III	Basic Sex Education Overview, ground rules, and a pre-test Basics of Urinary system and Reproductive system. Male puberty — physical and emotional changes Female puberty — physical and emotional changes Male-female similarities and differences Sexual intercourse, pregnancy, and childbirth Facts, attitudes, and myths about LGBTQ+ issues and identities Birth control and abortion Sex without love — harassment, sexual abuse, and rape Prevention of sexually transmitted diseases.	
IV	Mental Health and Psychological First Aid What is Mental Health First Aid? Mental Health Problems in the India The Mental Health First Aid Action Plan Understanding Depression and Anxiety Disorders Crisis First Aid for Suicidal Behavior & Depressive symptoms What is Non-Suicidal Self-Injury? Non-crisis First Aid for Depression and Anxiety Crisis First Aid for Panic Attacks, Traumatic events Understanding Disorders in Which Psychosis may Occur Crisis First Aid for Acute Psychosis Understanding Substance Use Disorder Crisis First Aid for Overdose, Withdrawal Using Mental Health First Aid	

Suggested Readings:

- Indian First Aid Manual - <https://www.indianredcross.org/publications/FA-manual.pdf>
- Red Cross First Aid/CPR/AED Instructor Manual
- <https://mhfa.com.au/courses/public/types/youthedition4>
- Finkelhor, D. (2009). The prevention of childhood sexual abuse. Durham, NH: Crimes Against Children Research Center. www.unh.edu/ccrc/pdf/CV192.pdf
- Kantor L. & Levitz N. (2017). Parents' views on sex education in schools: How much do Democrats and Republicans agree? PLoS ONE, 12(7): e0180250.
- Orenstein, P. (2016). Girls and sex: Navigating the complicated new landscape. New York, NY: Harper.

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- Schwiengershausen, E. (2015, May 28). The Cut. www.thecut.com/2015/05/most-women-are-catcalled-before-they-turn-17.html
- Wiggins, G. & McTighe, J. (2008). Understanding by design. Alexandria, VA: ASCD.



Co-curricular course: Semester-3
Course Title: Human Values and Environment studies

Syllabus: Human Values and Environment studies

Programme/Class: B.Sc.	Year: Second	Semester: Third
Co-Curricular Course		
Course Code: UCC0003	Course Title: Human Values and Environment studies	
Course outcomes:		
The mission of the course on Human Values and Environmental Studies is to create morally articulate solutions to be truthful and just and to become responsible towards humanity. The course seeks to establish a continuous interest in the learners to improve their thought process with intent to develop a new generation of responsible citizens capable of addressing complex challenges faced by the society due to disruptions in human interactions effecting human values. This course works towards		
• Building fundamental knowledge of the interplay of markets, ethics, and law, • Look at various challenges faced by individual to counter unethical issues • Look at core concepts for business ethics • Look at core concepts of anti-corruption • Look at core concepts for a morally articulate solution evolver to management issues in general, • Issues of sustainable development for a better environment. • To know how environmental degradation has taken place. • Be aware of negotiations and international efforts to save environment. • How to develop sustainably? • Efforts taken up by UN in Sustainable Development. • Efforts taken by India in Sustainable Development.		
The course intends to create a sense of how to be more responsible towards the environment. Upon finishing of the course students will be able to come up with using ethical reasoning for decision making and frame ethical issues as well as operationalise ethical choices. The course integrates various facets of human values and environment.		
Credits: 2		
Max. Marks: 40+60	Min. Passing Marks: 40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 2-0-0		
As the course requires two areas of Human Values and Environment Studies institutions can even opt for a parallel delivery		

Unit	Topics	No. of Lectures Total=30
I	Human Values- Introduction- Values, Characteristics, Types, Developing Value system in Indian Organisation, Values in Business Management, value based Organisation, Trans-cultural Human values in Management. Swami Vivekananda's philosophy of Character Building, Gandhi's concept of Seven Sins, APJ Abdul Kalam view on role of parents and Teachers. Human Values and Present Practices – Issues: Corruption and Bribe, Privacy Policy in Web and Social Media, Cyber threats, Online Shopping etc. Remedies UK Bribery Act, Introduction to sustainable policies and practices in Indian Economy. Principles of Ethics Secular and Spiritual Values in Management- Introduction- Secular and Spiritual values, features, Levels of value Implementation. Features of spiritual Values, Corporate Social Responsibility- Nature, Levels, Phases and Models of CSR, Corporate Governance. CSR and Modern Business Tycoons Ratan Tata, Azim Premji and Bill Gates.	

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II	Holistic Approach in Decision making- Decision making, the decision making process, The Bhagavad Gita: Techniques in Management, Dharma and Holistic Management. Discussion through Dilemmas – Dilemmas in Marketing and Pharma Organisations, moving from Public to Private – monopoly context, Dilemma of privatisation, Dilemma on liberalization, Dilemma on social media and cyber security, Dilemma on Organic food, Dilemma on standardization, Dilemma on Quality standards. Case Studies	
III	• Ecosystem: Concept, structure & functions of ecosystem: producer, consumer, decomposer, foodweb, food chain, energy flow, Ecological pyramids • Conservation of Biodiversity- In-situ & Ex-situ conservation of biodiversity • Role of individual in Pollution control • Human Population & Environment • Sustainable Development • India and UN Sustainable Development Goals • Concept of circular economy and entrepreneurship	
IV	• Environmental Laws? • International Advancements in Environmental Conservation • Role of National Green Tribunal • Air Quality Index • Importance of Indian Traditional knowledge on environment • Bio assessment of Environmental Quality • Environmental Management System • Environmental Impact Assessment and Environmental Audit	

Suggested Readings:

1. A foundation course in Human Values and Professional Ethics by RR. Gaur, R. Sangal et.al
2. JUSTICE: What's the Right Thing to Do? Michael J. Sandel.
3. Human Values by A. N. Tripathi New Age International
4. Environmental Management by N.K. Uberoi
5. <https://www.un.org/sustainabledevelopment/sustainable-development-goals/>
6. <https://www.india.gov.in/my-government/schemes>
7. <https://www.legislation.gov.uk/ukpga/2010/23/contents>
8. Daniel Kahneman, Thinking, Fast and Slow; Allen Lane Nov 2011 ISBN: 9780141918921

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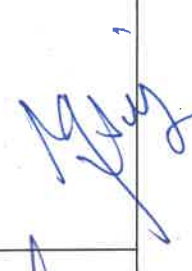


Co-curricular course: Semester-4
Course Title: Physical Education and Yoga

Syllabus: Physical Education and Yoga

Programme: B.Sc.	Year: First	Semester: Forth
Co-Curricular Course		
Course Code: UCC004	Course Title: Physical Education and Yoga	
Course outcomes: Students will learn the introduction of Physical Education, Concept of fitness and wellness, Weight management and lifestyle of an individual. The student will also learn about the relation of Yoga with mental health and value Education. In this course student will also learn about the aspects of the Traditional games of India.		
Credits: 2	Compulsory	
Max. Marks: 40+60	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 2-0-0		

Unit	Topics	No. of Lectures Total=30
I	Physical Education: • Meaning, Definition, Aim and Objective. • Misconception About Physical Education. • Need, Importance and Scope of Physical Education in the Modern Society. • Physical Education Relationship with General Education. • Physical Education in India before Independence. • Physical Education in India after Independence.	
II	Concept of Fitness and Wellness: • Meaning, Definition and Importance of Fitness and Wellness. • Components of Fitness. • Factor Affecting Fitness and Wellness. Weight Management: • Meaning and Definition of Obesity. • Causes of Obesity. • Management of Obesity. • Health problems due to Obesity. Lifestyle: • Meaning, Definition, Importance of Lifestyle. • Factor affecting Lifestyle. • Role of Physical activity in the maintains of Healthy Lifestyle.	
III	Yoga and Meditation: • Historical aspect of yoga. • Definition, types scopes & importance of yoga. • Yoga relation with mental health and value education. • Yoga relation with Physical Education and sports. • Definition of Asana, differences between asana and physical exercise. • Definition and classification of pranayama. • Difference between pranayama and deep breathing. • Practical: Asana, Suraya-Namaskar, Bhujang Asana, Naukasana, Halasana, Vajrasana, Padmasana, Shavasana, Makrasana, Dhanurasana, Tad Asana. Pranayam: Anulom, Vilom.	
IV	Traditional Games of India: • Meaning. • Types of Traditional Games – Gilli-Danda, Kanche, Stapu, Gutte, etc. • Importance/ Benefits of Traditional Games. • How to Design Traditional Games. Recreation in Physical Education:	



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• Meaning, Definition of Recreation. • Scope and Importance of Recreation. • General Principles of Recreation. • Types of Recreational Activities. • Aerobics and Zumba. (Fir India Movement)	
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Suggested Readings:

- Singh, Ajmer, Physical Education and Olympic Abhiyan, "Kalayani Publishers", New Delhi, Revised Addition, 2006
- Patel, Shri krishna, Physical Education, "Agrawal Publishers", Agra, 2014-15
- Panday, Preeti, Sharirik Shiksha Sankalan, "Khel Sanskriti Prakashan, Kanpur
- Kamlesh M.L., "Physical Education, Facts and foundations", Faridabad P.B. Publications.
- B.K.S. Yengar, "Light and Yog. Yoga Deepika", George Allen of Unwin Ltd., London, 1981.
- BrajBilari Nigam, Yoga Power "The Kpath of Personal achievement" Domen and Publishers, New Delhi, 2001.
- Indira Devi, "Yoga for You", Gibbs, Smith Publishers, Salt Lake City, 2002 Domenand Publishers, New Delhi - 2001.
- Jack Peter, "Yoga Master the Yogic Powers", Abhishek Publications, Chandigarh, 2004.
- Janice Jerusalem, "A Guide To Yoga" Parragon Bath, Baiihe-2004.

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Co-curricular course: Semester-5
Course Title: Analytic Ability and Digital Awareness

Co-Curricular Course name: Analytic Ability and Digital Awareness

Programme/Class:	Bachelor of Science
Year:	Third
Semester:	Fifth
Subject: Co-Curricular Course	
Course Code: Z050501	Course Title: Analytic Ability and Digital Awareness

Course outcomes (Analytic Ability):

- CO 1: Familiarize with analogy, number system, set theory and its applications, number system and puzzles.
- CO 2: To understand the basics of Syllogism, figure problems, critical and analytical reasoning.
- CO 3: Familiarize with word processing application and worksheet.
- CO 4: To understand the basics of web surfing and cyber security.

Credits: 2 Co-Curricular

Max. Marks: 40+60 Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): 2-0-0

Unit	Topic	No. of Lectures
I	Alphabet test, Analogy, Arithmetic Reasoning, Blood relations, Coding and Decoding, Inequalities, Logical Venn diagram, Seating Arrangements, Puzzles and Missing numbers	
II	Syllogism, Pattern completion and figure series, Embedded Figure and counting of figures, Cube & Dice, Paper cutting and folding, Data sufficiency, Course of Action, Critical Reasoning, Analytical and decision making	
III	Computer Basics: Block diagram of Digital Computer, Classification of Computers, Memory System, Primary storage, Auxiliary memory, Cache memory, Computer Software (System/Application Software), MS Word Basics: The word screen, Getting to word documents, typing and Revising text, Finding and Replacing, Editing and Proofing tools, Formatting text characters, Formatting Paragraph, Document templates., Page set up, tables, Mail Merge, Macros, protecting documents, printing a document. MS-Excel Introduction, Worksheet basics, Creating worksheet, Heading information, Data & Text, Date & Time, Alphanumeric values, Saving & quitting worksheet, Opening and moving around in an existing worksheet, Toolbars and Menus, Excel shortcut and function keys, Working with single and multiple workbook, Working with formulae & cell referencing, Auto sum, coping formulae, Absolute & relative addressing, Worksheet with ranges, Formatting of worksheet, Previewing & Printing worksheet, Graphs and charts, Database, Creating and using macros, Multiple worksheets-concepts Introduction of Open Source Applications: LibreOffice, OpenOffice and Google Docs etc.	
IV	Web Surfing: An Overview: working of Internet, Browsing the Internet, E-Mail, Components of E-Mail, Address Book, Troubleshooting in E-Mail, Browsers: Netscape Navigator, Microsoft Internet Explorer, Google Chrome, Mozilla Firefox, Tor, Search Engines like Google, DuckDuckGo etc, Visiting web sites: Downloading. Cyber Security: Introduction to Information System, Type of information system, CIA model of Information Characteristics, Introduction to Information Security, Need of Information Security, Cyber Security, phishing, spamming, fake news, general issues related to cyber security, Business need, Ethical and Professional issues of security.	

Suggested Readings:

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- Sharma, A., "How to prepare for Data Interpretation and Logical Reasoning for the CAT" McGraw Hill Education Pvt. Ltd., New Delhi, India, 2011, Ed. 5, ISBN 978 2007 070 481
- Aggarwal, R.S., "A Modern Approach to Verbal and Non-verbal Reasoning" S. Chand Publishers New Delhi, India, 2010, ISBN 10: 8121905516
- Madan, Sushila, Introduction to Essential tools, Jain Book Agency, New Delhi/India, 2009, 5th ed.
- Goel, Anita, Computer Fundamentals, Pearson Education, India, 2012
- Michael E. Whitman and Herbert J. Mattord, "Principles of Information Security," Sixth Edition, Cengage Learning, 2017


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Co-curricular course: Semester-6
Course Title: Communication Skills and Personality Development

Co-curricular Certificate course 'Communication Skills and Personality Development'

Programme: B.Sc.	Year: Third	Semester: Sixth
Co-Curricular Course		
Course Code: Z060601	Course Title: Communication Skills and Personality Development	
Course outcomes:		
• To understand the concept of Personality. • To learn what personal grooming pertains. • To learn to make good resume and prepare effectively for interview. • To learn to perform effectively in group discussions. • To explore communication beyond language. • To learn to manage oneself while communicating. • To acquire good communication skills and develop confidence.		
Credits: 2	Compulsory	
Max. Marks: 40+60	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 2-0-0		

Unit	Topics	No. of Lectures Total=30
I	PERSONALITY AND PERSONAL GROOMING Understanding Personality • Definition and Meaning of Personality • Types of Personality • Components of Personality • Determinants of Personality • Assessment of Personality Grooming Self • Dress for success • Make up & skin care • Hair care & styles for formal look • Art of accessorizing • Oral Hygiene	
II	INTERVIEW PREPARATION AND GROUP DISCUSSION • Meaning and Types of Interview [Face to Face, Telephonic, Video] • Interview procedure [Opening, Listening, Closure] • Preparation for Interview • Resume Writing • LinkedIn Etiquette • Meaning and methods of Group Discussion • Procedure of Group Discussion. • Group Discussion simulation • Group discussion common error	
III	BODY LANGUAGE AND BEHAVIOUR • Concept of human behavior • Individual and group behavior • Developing Self-Awareness • Behaviour and body language • Dimensions of body language: Proxemics, Haptics, Oculistics, Paralanguage, Kinesics, Sign Language, Chromatics, Chronemics, Olfactics • Cultural differences in Body Language • Business Etiquette & Body language	

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	• Body Language in the Post Corona Era • Virtual Meeting Etiquette • Social Media Etiquette	
IV	ART OF GOOD COMMUNICATION • Communication Process • Verbal and Non-verbal communication • 7 C's of effective communication • Barriers to communication • Paralinguistics: Pitch, Tone, Volume, Vocabulary, Word stress, Pause • Types of communication: Assertive, Aggressive, Passive Aggressive • Listening Skills • Questioning Skills • Art of Small Talk • Email Writing	

Suggested Readings:

1. Cloninger, S.C., "Theories of Personality : Understanding Person", Pearson, New York, 2008, 5th edition.
2. Luthans F, "Organizational Behaviour", McGraw Hill, New York, 2005, 12th edition.
3. Barron, R.A. & Brian D, "Social Psychology", Prentice Hall of India, 1998, 8th edition.
4. Adler R.B., Rodman G. & Hutchinson C.C., "Understanding Human Communication", Oxford University Press: New York, 2011.

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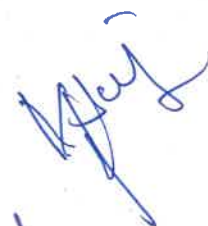
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11. Ordinance

This section records the Ordinance governing the B.Sc. (PCM) programme, as applicable under the First Statutes of Future University and the relevant UGC Regulations, including provisions relating to eligibility for admission, duration of the programme, scheme of examination, promotion criteria, attendance requirements, and award of the degree.

The detailed Ordinance document, once finalised and approved by the Academic Council and the Board of Management, shall be appended to this file as a controlled document and updated periodically to reflect regulatory changes.

- Eligibility for Admission: As per the University's admission policy notified for the relevant academic session.
- Duration of the Programme: Three years (six semesters), extendable as per the Credit Framework and University norms for slow-paced learners.
- Attendance Requirement: A minimum of 75% attendance in each course is required to be eligible to appear in the end-semester examination, subject to condonation as per University rules.
- Promotion Criteria and Award of Degree: As per the Scheme of Examination and Evaluation approved by the Academic Council.



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12. Annexure

The following documents are annexed / to be annexed to this Board of Studies file for record and reference:

- Annexure I: Detailed practical/laboratory manual for each paper.
- Annexure II: List of reference books and text books recommended for each paper.
- Annexure III: Mapping of Course Outcomes (COs) to Programme Outcomes (POs)/Programme Educational Objectives (PEOs).
- Annexure IV: CVs/brief profiles of the external experts who attended the meeting.

These annexures shall be compiled and appended by the Dean's office prior to final submission of this file to the Academic Council.

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