

# NATIONAL EDUCATION POLICY-2020

## Syllabus for Sri Dev Suman Uttarakhand University and Affiliated Colleges



### PROPOSED STRUCTURE OF Under Graduate Physics Course Syllabus

2022



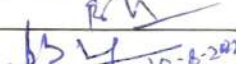
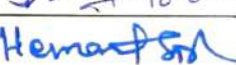

## Board Of Studies

Department of Physics, Sri Dev Suman Uttarakhand University

Pt. Lalit Mohan Sharma Campus Rishikesh

### Syllabus Preparation Committee


A: Department of Physics, Sri Dev Suman Uttarakhand University, Pt. Lalit Mohan Sharma Campus, Rishikesh

S.N.	Name	Designation	Signature
1.	Dr. Yogesh Kumar Sharma	Professor & Head	 10/8/22
2.	Dr. Manoj Yadav	Professor	
3.	Dr. Rajkumar Tyagi	Professor	
4.	Dr. Bimal Prakash Bahuguna	Professor	 10-8-2022
5.	Dr. Hemant Singh	Associate Professor	 Hemant Singh

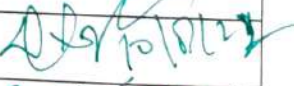
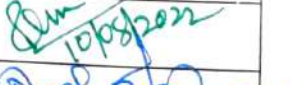
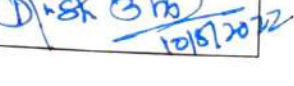
### B: Director from Research Institute

1.	Professor Durgesh Pant	Director General UCOST, Dehradun	
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### C: Expert from Other Institutions

1.	Dr. A. A. Baurai	Professor & Director S. R. T Campus, Badshahithol Tehri (Garhwal) H. N. B. Garhwal Univeristy Srinagar (Garhwal)	
2.	Dr. D. P. Bhatt	Professor & Principal Govt. Degree College, Vedhikhal	

### D: Invited Principals from Government Post Graduate Colleges

S. N.	Name	Designation and Address	Signature
1.	Dr. D. C. Nainwal	Professor & Principal Govt. P. G. College, Doiwala	 10/8/22
2.	Dr. Renu Negi	Professor & Principal Govt. P. G. College, New Tehri	 10/8/2022
3.	Dr. D. P. Bhatt	Professor & Principal Govt. Degree College, Vedhikhal	 10/8/2022

List of Papers in Six Semesters (B.Sc. Degree)					
Semester-wise Titles of the Papers in Physics					
Year	Sem.	Course Code	Paper Title	Theory/ Practical	Credits
<i>Certificate Course in Basic Physics</i>					
FIRST YEAR	I		Mechanics	Theory	(04)
			Mechanical Properties of Matter	Practical	(02)
	II		Electricity and Magnetism	Theory	(04)
			Demonstrative Aspects of Electricity & Magnetism	Practical	(02)
<i>Diploma in Applied Physics</i>					
SECOND YEAR	III		Thermodynamics and Statistical Physics	Theory	(04)
			Demonstrative Aspects of Thermal Properties of Matter	Practical	(02)
	IV		Optics	Theory	(04)
			Demonstrative Aspects of Optics	Practical	(02)
<i>Bachelor of Science</i>					
THIRD YEAR	V		Solid State Physics	Theory	(04)
			Demonstrative Aspects of Solid State Physics & Circuit Designing	Practical	(02)
			Basic Electronics	Theory	(04)
			Demonstrative Aspects of Basic Electronics	Practical	(02)
	VI		Modern Physics & Elementary Quantum Mechanics	Theory	(04)
			Demonstrative Aspects of Modern Physics	Practical	(02)
			Analog and Digital Electronics	Theory	(04)
			Demonstrative Aspects of Analog & Digital Circuits	Practical	(02)

**Subject prerequisites:**

1. For Semester I: 12<sup>th</sup> pass with subjects Physics, Chemistry & Mathematics
2. For Semester II: Passed Semester I with Physics
3. For Semester III: Passed Semester II with Certificate Course in Basic Physics
4. For Semester IV: Passed Semester III
5. For Semester V: Passed Semester IV with Diploma in Applied Physics
6. For Semester VI: Passed Semester V

**Programme outcomes (POs):**

Students having Degree in B.Sc. (with Physics) should have knowledge of different concepts and fundamentals of Physics and ability to apply this knowledge in various fields of academics and industry. They may pursue their future career in the field of academics, research and industry.

<b>PO 1</b>	<ol style="list-style-type: none"><li>1. Competence in the methods and techniques of calculations using Mechanics.</li><li>2. Students are expected to have hands-on experience to apply the theoretical knowledge to solve practical problems.</li></ol>
<b>PO2</b>	<ol style="list-style-type: none"><li>1. Students are expected to have deep understanding of electricity and magnetism.</li><li>2. Student should be able to make basic electrical circuits and handle electrical instruments.</li></ol>
<b>PO 3</b>	<ol style="list-style-type: none"><li>1. Competence in the concepts of Thermodynamics and Statistical Physics.</li><li>2. Students are expected to have hands on experience in Thermal Physics and Statistical Physics Experiments.</li></ol>
<b>PO 4</b>	<ol style="list-style-type: none"><li>1 Knowledge of different concepts in Optics.</li><li>2 Students are expected to have hands on experience of Experiments of Optics</li></ol>
<b>PO 5</b>	<ol style="list-style-type: none"><li>1. Knowledge of basic concepts of Solid State Physics with their applications</li><li>2. Students are expected to have an insight in handling electronic instruments.</li></ol>
<b>PO 6</b>	<ol style="list-style-type: none"><li>1. Comprehensive knowledge of Analog &amp; Digital Principles and Applications.</li><li>2. Learn the integrated approach to analog electronic circuitry and digital electronics for R&amp;D.</li></ol>

**Programme specific outcomes (PSOs):**  
*UG I Year / Certificate course in Basic Physics*

After completing this certificate course, the student should have

- Acquired the basic knowledge of Mechanics, Electricity and Magnetism.
- Hands-on experience to apply the theoretical knowledge to solve practical problems of basic physical phenomena. He should be able to carry out experiments to understand the laws and concepts of Physics.
- An insight in understanding electrical circuits and in handling electrical instruments.

**Programme specific outcomes (PSOs):**  
**UG II Year/ (Diploma in Applied Physics)**

After completing this diploma course, the student should have

- Knowledge of different concepts in Thermodynamics, Statistical Physics and Optics.
- Knowledge of different aspects of Thermal Physics which serves as a basis for many physical systems used in industrial applications and deals with the physics and technology of Engines and Refrigerators.
- A deeper insight in Optics to understand the Physics of many optical instruments which are widely used in research and Industry, Optoelectronics, IT and communication devices, and in industrial instrumentation.
- Knowledge of basic concepts of optical instruments with their applications in technology.



<b>Programme specific outcomes (PSOs): UG III Year / Bachelor of Science</b>	
After completing this degree course, the student should have:	
<b>PSO 1</b>	<i>Knowledge of Mechanics and basic properties of matter. The course will empower him to apply his theoretical knowledge in various physical phenomena that occur in day to day life and he can use this scientific knowledge for the betterment of the society.</i>
<b>PSO2</b>	<i>Understanding of basic concepts related to Electricity and Magnetism. He should be proficient in designing and handling different electrical circuits</i>
<b>PSO3</b>	<i>Expertise in different aspects of Thermal and Statistical Physics which serves as a basis for many physical systems used in industrial applications and deals with the physics and technology of Engines and Refrigerators.</i>
<b>PSO4</b>	<i>Proficient in the field of Optics which will increase his demand in research and industrial establishments engaged in activities involving optical instruments.</i>
<b>PSO5</b>	<i>Basic knowledge in the field of Modern physics, which have utmost importance at both undergraduate and graduate level.</i>
<b>PSO6</b>	<ul style="list-style-type: none"> <li>• <i>Comprehensive knowledge of Analog &amp; Digital Principles and Applications.</i></li> <li>• <i>Learn the integrated approach to analog electronic circuitry and digital electronics for R&amp;D.</i></li> </ul>

<b>CERTIFICATE COURSE IN BASIC PHYSICS</b>		
<b>Programme:</b> <i>Certificate Course in Basic Physics</i>		<b>Year: I</b>   <b>Semester: I</b> <b>Paper-I</b>
<b>Subject: Physics</b>		
<b>Course Code:</b>	<b>Course Title: Mechanics</b>	
<b>Course Outcomes</b>		
<ol style="list-style-type: none"> <li>1. Understanding of Vector Algebra and Vector Calculus.</li> <li>2. Understand the physical interpretation of gradient, divergence and curl.</li> <li>3. Study of gravitational field and potential and understanding of Kepler's laws of Planetary motion.</li> <li>4. Understanding of different frames of references and conservation laws.</li> <li>5. Understand the dynamics of rigid body and concept of moment of inertia. Study of moment of inertia of different bodies and its applications.</li> <li>6. Study the properties of matter, response of the classical systems to external forces and their elastic deformation and its applications.</li> <li>7. Comprehend the dynamics of Fluid and concept of viscosity and surface tension along with its applications.</li> <li>8. Understanding the basic idea of waves and oscillations through Simple harmonic motion.</li> </ol>		
<b>Credits: 04</b>		<b>Core Compulsory</b>
<b>Max. Marks: 100</b> <b>External Exam: 75</b> <b>Internal Assessment: 25</b>		<b>Min. Passing Marks: 33</b>
<b>Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0</b>		
<b>Unit</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>Unit I</b>	<b>Vectors Algebra</b> Vector algebra. Scalar and vector products, scalar and vector triple products, Derivative of a vector with respect to a parameter, Del operator, gradient, divergence and curl, Gauss divergence theorem and applications, Stokes curl theorem and applications; and Green's theorem, Line, surface and volume integral of a vector function.	<b>10</b>

<b>Unit II</b>	<b>Gravitation field and potential</b> Gravitational field and potential, Gravitational potential energy, Gravitational field Intensity and potential due to a ring, a spherical shell, solid sphere and circular disc, gravitational self-energy, Inverse square law of forces, Kepler's laws of planetary motion.	<b>10</b>
<b>Unit III</b>	<b>Conservation Laws</b> Frames of reference, Concept of inertial and Non-inertial frames of references, Work energy theorem, Conservative and non-Conservative forces, Linear restoring force, Gradient of potential, Conservation of energy for the particle; Energy function, Concept of Centre of mass, Angular momentum and torque, Laws of conservation of total energy, total linear momentum and total angular momentum along with their examples.	<b>10</b>
<b>Unit IV</b>	<b>Dynamics of rigid body and Moment of Inertia</b> Translatory and Rotatory motion, Equation of motion for Rotating rigid body, angular momentum vector and moment of inertia, Theorem of parallel and perpendicular axes, Moment of inertia of a cylinder, rod, lamina, ring, disc, spherical shell, solid sphere, kinetic energy of rotation, rolling along a slope, Application to compound pendulum.	<b>10</b>
<b>Unit V</b>	<b>Properties of Matter</b> Basic concept, Elastic constants and their Interrelations, torsion of cylinder, bending of beam, bending moment, Cantilever, shape of Girders/ rail tracks. Viscosity, Stokes's law, Poiseuille's formula, Equation of continuity, Bernoulli's theorem, Surface tension and its molecular interpretation.	<b>10</b>
<b>Unit VI</b>	<b>Waves and Oscillations</b> Characteristics, Differential equation of a wave motion, Periodic motion, SHM in mechanical systems, Energy of Simple harmonic oscillator, Superposition of SHM(s), Applications of Simple harmonic motion in compound pendulum, Torsional pendulum and LC circuit, Composition of two SHM(s) of different frequency ratio, Lissajous' figures for equal frequencies ratio and 2:1 frequencies ratio.	<b>10</b>

### Suggested Reading

1. R. Resnick and D. Halliday: Physics Vol-I
2. Berkeley Physics Course: Mechanics Vol-I
3. R. P. Feynman, R. B. Leighton and M. Sands: The Feynman Lectures in Physics
4. D. S. Mathur: Mechanics
5. D. S. Mathur: Elements of Properties of Matter
6. Murray Spiegel, Seymour Lipschutz, Dennis Spellman: Schaum's Outline Series: Vector Analysis, McGraw Hill, 2017.
7. J. C. Upadhyaya: Mechanics

**Suggested Online Link:**

1. MIT Open Learning - Massachusetts Institute of Technology, <https://openlearning.mit.edu/>
2. National Programme on Technology Enhanced Learning (NPTEL),  
<https://www.youtube.com/user/nptelhrd>
3. Swayam Prabha - DTH Channel,  
[https://www.swayamprabha.gov.in/index.php/program/current\\_he/8](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

**This course can be opted as an elective by the students of following subjects:** The course can be opted as an elective, which is open to all students.

**Suggested Continuous Evaluation (25 Marks):**

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

**Class Test/Assignment- (25 marks)**

**Course Prerequisites:** Physics and Mathematics in 12<sup>th</sup>

<b>CERTIFICATE COURSE IN BASIC PHYSICS</b>		
<b>Programme:</b> <i>Certificate Course in Basic Physics</i>		<b>Year: I</b> <b>Semester: I</b> <b>Practical</b>
<b>Subject: Physics (Practical)</b>		
<b>Course Code</b>	<b>Course Title:</b> Mechanical Properties of Matter (Practical)	
<b>Course Outcomes:</b> 1. Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the mechanical properties. 2. Measurement precision and perfection is achieved through Lab Experiments.		
<b>Credits: 02</b>		<b>Core Compulsory</b>
<b>Max. Marks: 50</b> <b>Internal (Record File): 15</b> <b>External Practical Exam: 20</b> <b>External Viva Voce: 15</b>		<b>Min. Passing Marks: 17</b>
<b>Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-4</b>		
<b>Unit</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>Lab Experiment List</b>		
	<ol style="list-style-type: none"> <li>1. To study the Motion of Spring and calculate (a) Spring constant, (b) <math>g</math> and (c) Modulus of rigidity.</li> <li>2. To determine the Moment of Inertia of a Flywheel.</li> <li>3. To determine the Moment of Inertia of a Inertia table</li> <li>4. To determine <math>g</math> and velocity for a freely falling body using Digital Timing Technique.</li> <li>5. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).</li> <li>6. To determine the Young's Modulus of a Wire by Optical Lever Method.</li> <li>7. To determine the Young's Modulus by bending of beam.</li> <li>8. To determine the Modulus of Rigidity of a Wire by Maxwell's needle</li> <li>9. To determine the elastic Constants of a wire by Searle's method.</li> <li>10. To determine the value of <math>g</math> using Bar Pendulum.</li> <li>11. To determine the value of <math>g</math> using Kater's Pendulum.</li> <li>12. To determine Surface Tension.</li> <li>13. To determine the modulus of rigidity by Barton's apparatus (Horizontal/Vertical)</li> </ol>	<b>60</b>

### **Suggested Readings:**

1. B. L. Worsnop, H. T. Flint, “Advanced Practical Physics for Students”, Methuen & Co., Ltd., London, 1962.
2. S. Panigrahi, B. Mallick, “Engineering Practical Physics”, Cengage Learning India Pvt. Ltd., 2015.
3. Indu Prakash: Practical Physics
4. S. L. Gupta, V. Kumar, “Practical Physics”, Pragati Prakashan, Meerut, 2014.

### **Suggestive Digital Platforms / Web Links:**

1. Virtual Labs at Amrita Vishwa Vidyapeetham, <https://vlab.amrita.edu/?sub=1&brch=74>
2. Digital Platforms /Web Links of other virtual labs may be suggested / added to this list by individual Universities

### **Suggested Continuous Evaluation Methods:**

Continuous internal evaluation shall be based on attendance of student in Lab and presentation of practical in the record file. The marks shall be as follows

#### **Record File (15 marks)**

**PREREQUISITE:** Opted / Passed Semester I, Theory Paper-1

#### **Further Suggestions:**

- The institution may suggest a minimum number of experiments (say 6) to be performed by each student per semester from the Lab Experiment List.

<b>CERTIFICATE COURSE IN BASIC PHYSICS</b>		
<b>Programme:</b> <i>Certificate Course in Basic Physics</i>		<b>Year: I</b> <b>Semester: I</b> <b>Vocational/Minor</b>
<b>Subject: Physics</b>		
<b>Course Code:</b>	<b>Course Title: Basic Instrumentation Skills</b>	
<b>Credits: 03</b>		<b>Vocational/Minor (Experiments/hands on training)</b>
<b>Max. Marks: 100</b> <b>External Exam: 75</b> <b>Internal Assessment: 25</b>		<b>Min. Passing Marks: 33</b>
<b>Total No. of Lectures-Tutorials-Practical (in hours per week): 3-0-0</b>		
<b>Unit</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>Unit I</b>	<b>Basics of Measurement</b> Instruments accuracy, precision, sensitivity, resolution, range, least count of different instruments etc. Errors in measurements and loading effects. Principle of Galvanometer, Voltmeter and Ammeter, Conversion of galvanometer into voltmeter and ammeter.	<b>15</b>
<b>Unit II</b>	<b>Multimeter</b> Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity.	<b>10</b>
<b>Unit III</b>	<b>Digital Multimeter</b> Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/frequency counter, time-base stability, accuracy and resolution.	<b>10</b>
<b>Unit IV</b>	<b>Digital Instruments:</b> Comparison of analog and digital instruments. Characteristics of a digital meter. Working principle of digital voltmeter.	<b>10</b>

### **Suggested Reading**

1. B. L. Theraja: A text book in Electrical Technology
2. M. G. Say: Performance and design of AC machines
3. Venugopal: Digital Circuits and Systems
4. P. Vingron, Shimon: Logic Circuit Design
5. Subrata Ghoshal: Digital Electronics.
6. S. Salivahanan & N. S. Kumar: Electronic Devices and Circuits, 3rd Edn



**Suggested Online Link:**

1. MIT Open Learning - Massachusetts Institute of Technology, <https://openlearning.mit.edu/>
2. National Programme on Technology Enhanced Learning (NPTEL),  
<https://www.youtube.com/user/nptelhrd>
3. SwayamPrabha - DTH Channel,  
[https://www.swayamprabha.gov.in/index.php/program/current\\_he/8](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

**Suggested Continuous Evaluation (25 Marks):**

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

**Class Test/Assignment (25 marks)**

<b>CERTIFICATE COURSE IN BASIC PHYSICS</b>		
<b>Programme:</b> <i>Certificate Course in Basic Physics</i>		<b>Year: I</b> <b>Semester: II</b> <b>Paper-I</b>
<b>Subject: Physics</b>		
<b>Course Code:</b>	<b>Course Title: Electricity and Magnetism</b>	
<b>Course Outcomes:</b>		
<ol style="list-style-type: none"> <li>1. Understanding of Electric Field and Potential. Evaluation of Electric Field and Potential for different types of charge distributions.</li> <li>2. Study of Electric and Magnetic Fields in matter. Understand the concept of polarizability, Magnetization and Electric Displacement Vector.</li> <li>3. Study of Steady and Varying electric currents.</li> <li>4. Understanding of different aspects of alternating currents and its applications.</li> <li>5. Understand the Magnetostatics, Lorentz Force and Energy stored in magnetic Field.</li> <li>6. Comprehend the different aspects of Electromagnetic induction and its applications.</li> <li>7. Understanding the relation between electricity and magnetism.</li> </ol>		
<b>Credits: 04</b>		<b>Core Compulsory</b>
<b>Max. Marks: 100</b> <b>External Exam: 75</b> <b>Internal Assessment: 25</b>		<b>Min. Passing Marks: 33</b>
<b>Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0</b>		
<b>Unit</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>Unit I</b>	<b>Electric field and potential</b> Coulomb law, Gauss' theory, its integral and differential forms, line integral of Electric field, Electric field and potential due to an arbitrary charge distribution. Electrostatic energy, energy stored in an Electric field. Electric field and potential due to long charged wire, Spherical shell, sphere, disc, dipole.	<b>10</b>
<b>Unit II</b>	<b>Electric and Magnetic fields in Matter</b> Moments of charge distributions, Polar and non-polar molecule, polarization vector, electric displacement vector, three electric vectors, dielectric susceptibility and permittivity, polarizability, Clausius-Mossotti relation Magnetization, magnetic susceptibility, diamagnetic, paramagnetic and ferromagnetic substances, Hysteresis and B-H curve, hysteresis loss.	<b>10</b>
<b>Unit III</b>	<b>Electric Currents (Steady and Varying)</b> Current density, Equation of Continuity, Ohm's law and electrical conductivity, Kirchoff's Laws and their applications, Transient current, Growth and decay of D. C. in L - R and R - C circuits, charging and discharging of a capacitor through a resistance.	<b>10</b>

<b>Unit IV</b>	<b>Magnetostatics</b> Lorentz force, Bio-Savart's law, Ampere's law and application, Application of Biot-Savart law, magnetic field due steady current in a long straight wire, coil, Interaction between two wires, field due a Helmholtz coil, solenoid and current loop, magnetic vector potential, Energy stored in Magnetic field.	<b>10</b>
<b>Unit V</b>	<b>Electromagnetic Induction and Alternating Current</b> Faraday's laws of induction, Lenz's law, Electromotive force, Measurement of magnetic field, Eddy current, Mutual inductance, Self-inductance. Impedance, admittance and reactance, R-C, R-L and L-C circuits with alternating e.m.f. source, series and parallel L-C-R circuits, resonance and sharpness, Quality factor, Power in A. C. circuits, Choke coil.	<b>10</b>
<b>Unit VI</b>	<b>Maxwell's Equations</b> Review of electrostatic and electromagnetic equations, their differential and integral forms, Maxwell's equations. Displacement Current. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density.	<b>10</b>

### **Suggested Reading**

1. Edward M. Purcell: Electricity and Magnetism
2. J. H. Fewkes & J. Yarwood: Electricity & Magnetism, Vol. I
3. D C Tayal: Electricity and Magnetism, Himalaya Publishing House Pvt. Ltd., 2019.
4. D. J. Griffiths: Introduction to Electrodynamics.
5. Lal and Ahmed: Electricity and Magnetism
6. H. K. Malik and A. K. Singh: Engineering Physics, McGraw Hill Education (India) Private Limited, 2018.
7. Richard P. Feynman, Robert B. Leighton, Matthew Sands: The Feynman Lectures on Physics Vol. 2, Pearson Education Limited, 2012.

### **Suggested Online Link:**

1. MIT Open Learning - Massachusetts Institute of Technology, <https://openlearning.mit.edu/>
2. National Programme on Technology Enhanced Learning (NPTEL), <https://www.youtube.com/user/nptelhrd>
3. SwayamPrabha - DTH Channel, [https://www.swayamprabha.gov.in/index.php/program/current\\_he/8](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

**This course can be opted as an elective by the students of following subjects:** The course can be opted as an elective, which is open to all students.

### **Suggested Continuous Evaluation (25 Marks):**

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

### **Class Test/Assignment (25 marks)**

**Course Prerequisites:** Passed semester I, theory paper-1

CERTIFICATE COURSE IN BASIC PHYSICS		
Programme: <i>Certificate Course in Basic Physics</i>		Year: I Semester: II Practical
Subject: <b>Physics (Practical)</b>		
Course Code:	Course Title: Demonstrative Aspects of Electricity & Magnetism (Practical)	
<b>Course Outcomes:</b>		
<ol style="list-style-type: none"> <li>1. Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the electric and magnetic properties.</li> <li>2. Measurement precision and perfection is achieved through Lab Experiments.</li> </ol>		
<b>Credits: 02</b>		<b>Core Compulsory</b>
<b>Max. Marks: 50</b> <b>Internal (Record File): 15</b> <b>External Practical Exam: 20</b> <b>External Viva Voce: 15</b>		<b>Min. Passing Marks: 17</b>
<b>Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-4</b>		
Unit	Topic	No. of Lectures
<b>Lab Experiment List</b>		
	<ol style="list-style-type: none"> <li>1. Frequency of A.C. Mains.</li> <li>2. Melde's Experiment.</li> <li>3. Calibration of Voltmeter by potentiometer.</li> <li>4. Calibration of ammeter by potentiometer.</li> <li>5. Specific resistance determination by Carey Foster bridge.</li> <li>6. Conversion of a Galvanometer into a Voltmeter.</li> <li>7. Conversion of a Galvanometer into Ammeter.</li> <li>8. Variation of magnetic field along the axis of a current carrying circular coil.</li> <li>9. Electrochemical equivalent.</li> <li>10. De Sauty's bridge- <math>C_1/C_2</math></li> <li>11. <math>R_1/R_2</math> by potentiometer.</li> <li>12. Study of R-C, L-C-R circuits.</li> <li>13. Determination of self inductance, mutual inductance.</li> <li>14. Magnetic field determination by search coil and ballistic galvanometer.</li> <li>15. Sonometer.</li> </ol>	<b>60</b>

## **Suggested Readings:**

1. B. L. Worsnop, H.T. Flint, “Advanced Practical Physics for Students”, Methuen & Co., Ltd., London, 1962.
2. S. Panigrahi, B. Mallick, “Engineering Practical Physics”, Cengage Learning India Pvt. Ltd., 2015.
3. Indu Prakash: Practical Physics
4. S. L. Gupta, V. Kumar, “Practical Physics”, Pragati Prakashan, Meerut, 2014.

## **Suggestive Digital Platforms / Web Links:**

1. Virtual Labs at Amrita Vishwa Vidyapeetham, <https://vlab.amrita.edu/?sub=1&brch=74>
2. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by individual Universities

### **Suggested Continuous Evaluation Methods:**

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

#### **Record File (15 marks)**

**PREREQUISITE:** Passed Semester I

### **Further Suggestions:**

- The institution may suggest a minimum number of experiments (say 6) to be performed by each student per semester from the Lab Experiment List.

<b>CERTIFICATE COURSE IN BASIC PHYSICS</b>		
<b>Programme :</b> <i>Certificate Course in Basic Physics</i>		<b>Year: I</b> <b>Semester: II</b> <b>Vocational/Minor</b>
<b>Subject: Physics</b>		
<b>Course Code:</b>	<b>Course Title: Electronics Instrumentation skills</b>	
<b>Credits: 03</b>		<b>Vocational/Minor</b>
<b>Max. Marks: 100</b> <b>External Exam: 75</b> <b>Internal Assessment: 25</b>		<b>Min. Passing Marks: 33</b>
<b>Total No. of Lectures-Tutorials-Practical (in hours per week): 3-0-0</b>		
<b>Unit</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>Unit I</b>	<b>Electronic Voltmeter</b> Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter, Multimeter and their significance. AC millivoltmeter: Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac milli -voltmeter, specifications and their significance.	<b>10</b>
<b>Unit II</b>	<b>Cathode Ray Oscilloscope</b> Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance. Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.	<b>15</b>
<b>Unit III</b>	<b>Signal and pulse Generators</b> Block diagram, explanation and specifications of low frequency signal generator and pulse generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis.	<b>10</b>
<b>Unit IV</b>	<b>Impedance Bridges</b> Block diagram of bridge. Working principles of basic (balancing) RLC bridge. Specifications of RLC bridge. Block diagram and working principles of a Q-meter. Digital LCR bridges.	<b>10</b>

**Suggested Reading**

1. B. L. Theraja: Basic Electronics
2. M. G. Say: Performance and design of AC machines
3. Venugopal: Digital Circuits and Systems
4. P. Vingron, Shimon: Logic Circuit Design
5. Subrata Ghoshal: Digital Electronics
6. S. Salivahanan & N. S..Kumar: Electronic Devices and Circuits
7. V. K. Mehta: Basic Electronics

**Suggested Online Link:**

1. MIT Open Learning - Massachusetts Institute of Technology, <https://openlearning.mit.edu/>
2. National Programme on Technology Enhanced Learning (NPTEL),  
<https://www.youtube.com/user/nptelhrd>
3. SwayamPrabha - DTH Channel,  
[https://www.swayamprabha.gov.in/index.php/program/current\\_he/8](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

**Suggested Continuous Evaluation (25 Marks):**

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

**Class Test/Assignment (25 Marks)**



**Minor/Elective (04 Credit, One from the list E1 1)**

**Students having major in Physics will have to choose the elective/minor from sl. no. 1-4 only. Other students may have choice from sl. no. 1-6.**

1. Statistical Physics
2. Numerical Methods
3. Computer Programming
4. Waves and Oscillations
5. Fundamental Mechanics
6. Basic Electricity and Magnetism

<b>CERTIFICATE COURSE IN BASIC PHYSICS</b>		
<b>Programme:</b> <i>Certificate Course in Basic Physics</i>	<b>Year:</b> I	<b>Semester:</b> I/II
<b>Subject: Physics</b>		
<b>Course Code:</b>	<b>Course Title: Statistical Physics</b>	

<b>Credits: 04</b>	<b>Minor/Elective</b>
<b>Max. Marks: 100</b> <b>External Exam: 75</b> <b>Internal Assessment: 25</b>	<b>Min. Passing Marks: 33</b>

**Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0**

<b>Unit</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>Unit I</b>	<b>Basic Concepts in Statistical Physics</b> Basic postulates of Statistical Physics, Macro and Micro States, Phase Space, Density distribution in phase space, $\mu$ space representation and its division, Statistical average values, Condition of equilibrium, Stirling's Approximation, Entropy and Thermodynamic probability, Boltzmann entropy relation.	<b>15</b>
<b>Unit II</b>	<b>Ensembles and Thermodynamic connections</b> Ensembles, Micro -canonical, Canonical and Grand Canonical ensembles, Statistical definition of temperature and interpretation of second law of thermodynamic, Pressure, Entropy and Chemical potential. Entropy of mixing and Gibb's paradox, Partition function and Physical significances of various statistical quantities.	<b>15</b>
<b>Unit III</b>	<b>Classical Statistics</b> Maxwell-Boltzmann statistics and Distribution law, Energy distribution function, Maxwell Boltzmann law of velocity distribution (most probable velocity, average velocity, RMS velocity), Limitations of M-B statistics, Elementary idea of quantum statistics.	<b>15</b>

<b>Unit IV</b>	<b>Bose-Einstein and Fermi-Dirac Statistics</b> B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas, Bose derivation of Planck's law. Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit.	<b>15</b>
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### **Suggested Reading**

1. B. B. Laud: Introductions to Statistical Mechanics
2. J. K. Bhattacharjee: Statistical Physics (Allied Publishers)
3. F. Reif : Statistical Physics (Mc.Graw Hill)
4. Kamal Singh: Elements of Statistical Mechanics
5. K. Hung: Statistical Physics (Chapman and Hall/CRC)
6. K. E. Atkinson: Elementary Numerical Analysis
7. R. K. Pathria, B. Heinemann: Statistical Mechanics

### **Suggested Online Link:**

1. MIT Open Learning - Massachusetts Institute of Technology, <https://openlearning.mit.edu/>
2. National Programme on Technology Enhanced Learning (NPTEL), <https://www.youtube.com/user/nptelhrd>
3. Swayam Prabha - DTH Channel, [https://www.swayamprabha.gov.in/index.php/program/current\\_he/8](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

### **Suggested Continuous Evaluation (25 Marks):**

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

#### **Class Test/Assignment (25 marks)**

<b>CERTIFICATE COURSE IN BASIC PHYSICS</b>		
<b>Programme:</b> <i>Certificate Course in Basic Physics</i>		<b>Year: I</b> <b>Semester: I/II</b>
<b>Subject: Physics</b>		
<b>Course Code:</b>	<b>Course Title: Numerical Methods</b>	

<b>Credits: 04</b>	<b>Minor/Elective</b>
<b>Max. Marks: 100</b> <b>External Exam: 75</b> <b>Internal Assessment: 25</b>	<b>Min. Passing Marks: 33</b>

**Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0**

Unit	Topic	No. of Lectures
<b>Unit I</b>	<b>Ordinary Differential Equations</b> Brief review of ordinary differential equations, Exact equations, Equations reducible to exact equations, Equations of the first order and higher degrees, Clairaut's equation. Applications of ODEs in concerned engineering branch. Linear differential equations with constant co-efficient, Complimentary functions and particular integral, Method of variation of parameters, Equations reducible to linear equations with constant co-efficient (Cauchy's and Legendre's linear equations), Initial and Boundary value problems Simultaneous linear equations with constant co-efficient, Applications of differential equations in concerned engineering branch.	<b>15</b>
<b>Unit II</b>	<b>Partial Differential Equations</b> Formulation of Partial Differential Equations (PDE), Solution of PDE, Linear PDE of First Order (Lagrange's Linear Equation), Non-linear Equation of First Order (Standard Forms), Charpit's Method, Homogeneous Linear Equations with Constant Coefficients, Non-homogeneous Linear Equations. Applications of PDE: Method of separation of variables, Solution of one dimensional wave and heat equation and two dimensional Laplace's equation.	<b>15</b>
<b>Unit III</b>	<b>Transforms Theory</b> Laplace Transform: Laplace Transforms of standard functions and their properties, Inverse Laplace Transforms, General Properties of inverse Laplace transforms and Convolution Theorem, Laplace Transforms of periodic functions, Dirac-delta Function, Heaviside's Unit Function, Solution of ODE	<b>15</b>

	and linear simultaneous differential equations using Laplace transforms. Fourier Transform: Fourier integral representation, Fourier sine, cosine and complex transform, Finite Fourier Transforms and their applications. Z – Transforms: Z–Transforms & its properties, inversion of Z – transform and applications of Z – transform	
<b>Unit IV</b>	<b>Probability and Statistics</b> Review of probability, Conditional probability and sampling theorems, Discrete and Continuous Probability Distribution, Probability Mass & Probability Density Functions, Distribution function, Discrete and Continuous probability distributions, Binomial, Poisson and Normal distributions.	<b>15</b>

### **Suggested Reading**

1. Advanced Engineering Mathematics by E. Kreyszig, John Wiley and Sons, NC, New York.
2. Differential Equations by S. L. Ross, John Wiley & Sons, New York.
3. An Introduction to Probability Theory & its Applications by W. Feller, Wiley.
4. Probability and Statistics for Engineers and Scientists by R.E. Walpole, S. L. Myers and K. Ye, Pearson.
5. Integral Transforms and Their Applications by Lokenath Dennath and Dambaru Bhatta, Chapman and Hall/CRC Press.

### **Suggested Online Link:**

1. MIT Open Learning - Massachusetts Institute of Technology, <https://openlearning.mit.edu/>
2. National Programme on Technology Enhanced Learning (NPTEL), <https://www.youtube.com/user/nptelhrd>
3. Swayam Prabha - DTH Channel, [https://www.swayamprabha.gov.in/index.php/program/current\\_he/8](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

### **Suggested Continuous Evaluation (25 Marks):**

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

#### **Class Test/Assignment (25 marks)**

<b>CERTIFICATE COURSE IN BASIC PHYSICS</b>		
<b>Programme:</b> <i>Certificate Course in Basic Physics</i>	<b>Year:</b> I	<b>Semester:</b> I/II
<b>Subject: Physics</b>		
<b>Course Code:</b>	<b>Course Title: Computer Programming</b>	

<b>Credits: 04</b>	<b>Minor/Elective</b>
<b>Max. Marks: 100</b> <b>External Exam: 75</b> <b>Internal Assessment: 25</b>	<b>Min. Passing Marks: 33</b>

**Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0**

<b>Unit</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>Unit I</b>	<b>Programming Fundamentals</b> Introduction to computer, block diagram and organization of computer, number system and binary arithmetic, processing data, hardware, software, firmware, types of programming language -Machine language, Assembly level language, higher level language, source file, object file, translator-assembler, compiler, interpreter. Evolution and classification of programming languages.	<b>15</b>
<b>Unit II</b>	<b>Programming Techniques</b> Steps in program development, algorithm, flowchart, pseudo code. <b>C Language:</b> 'C' character set, literals, keywords, identifiers, data types and size, variable declaration, expression, labels, statements, formatted input output statements, types of operators, data type conversion, mixed mode arithmetics, control structures.	<b>15</b>
<b>Unit III</b>	<b>Data Structures</b> Storage classes, scope rules and visibility, arrays, pointers, dynamic storage allocation, structures and unions, self-referential structures. Relationship between pointers and arrays, dynamic arrays: Introduction to dynamic data structures linked lists, stack, and binary trees.	<b>15</b>
<b>Unit IV</b>	<b>Functions and File Handling</b> 'C' functions, library functions, parameter passing, recursion, 'C' files function for file handling, 'C' pre-processors and command line arguments, macros and conditional compiler directives.	<b>15</b>

**Suggested Reading**

1. C Programming Language by Brian W. Kenigham and Dennis Ritchie, Prentice Hall of India.
2. Programming with C by Byron Gottfried, Tata McGraw Hill.
3. The Complete Reference C by Herbert Schildt, Tata McGraw Hill.
4. Let us C by Yashwant Kanetkar, BPB Publication.
5. A Structured Programming Approach in C by B.A. Forouzan and R.F. Gilberg, Cengage Learning.

**Suggested Online Link:**

1. MIT Open Learning - Massachusetts Institute of Technology, <https://openlearning.mit.edu/>
2. National Programme on Technology Enhanced Learning (NPTEL),  
<https://www.youtube.com/user/nptelhrd>
3. Swayam Prabha - DTH Channel,  
[https://www.swayamprabha.gov.in/index.php/program/current\\_he/8](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

**Suggested Continuous Evaluation (25 Marks):**

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

**Class Test/Assignment (25 marks)**

<b>CERTIFICATE COURSE IN BASIC PHYSICS</b>		
<b>Programme:</b> <i>Certificate Course in Basic Physics</i>	<b>Year:</b> I	<b>Semester:</b> I/II
<b>Subject: Physics</b>		
<b>Course Code:</b>	<b>Course Title: Fundamental Mechanics</b>	

<b>Credits: 04</b>	<b>Minor/Elective</b>
<b>Max. Marks: 100</b> <b>External Exam: 75</b> <b>Internal Assessment: 25</b>	<b>Min. Passing Marks: 33</b>

**Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0**

<b>Unit</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>Unit I</b>	<b>Vectors Algebra and Ordinary Differential Equations</b> Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients.	<b>15</b>
<b>Unit II</b>	<b>Translatory and Rotatory Motion and Conservation Laws</b> Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass, Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets, Angular velocity and angular momentum. Torque. Conservation of angular momentum.	<b>15</b>
<b>Unit III</b>	<b>Gravitation</b> Newton's Law of Gravitation. Motion of a particle in a central force field (motion in a plane, angular momentum conservation). Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Basic idea of global positioning system (GPS). Weightlessness. Physiological effects on astronauts.	<b>15</b>
<b>Unit IV</b>	<b>Elasticity</b> Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire – Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion – Torsional pendulum-Determination of Rigidity modulus and moment of inertia - $q$ , $\eta$ and $\sigma$ by Searles method.	<b>15</b>



**Suggested Reading**

1. Sears, Zemansky and Young: University Physics
2. Berkeley Physics Course: Volume-1 Mechanics
3. Resnick, Halliday & Walker Fundamentals of Physics
4. Basudeb Bhattacharya: Engineering Mechanics 2nd Edn
5. Ronald Lane Reese: University Physics
6. B.L. Flint and H.T. Worsnop: Advanced Practical Physics for Students

**Suggested Online Link:**

1. MIT Open Learning - Massachusetts Institute of Technology, <https://openlearning.mit.edu/>
2. National Programme on Technology Enhanced Learning (NPTEL),  
<https://www.youtube.com/user/nptelhrd>
3. Swayam Prabha - DTH Channel,  
[https://www.swayamprabha.gov.in/index.php/program/current\\_he/8](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

**Suggested Continuous Evaluation (25 Marks):**

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

**Class Test/ Assignment (25 marks)**

<b>CERTIFICATE COURSE IN BASIC PHYSICS</b>		
<b>Programme:</b> <i>Certificate Course in Basic Physics</i>		<b>Year: I</b> <b>Semester:</b> I/II
<b>Subject: Physics</b>		
<b>Course Code:</b>	<b>Course Title: Waves and Oscillations</b>	

<b>Credits: 04</b>	<b>Minor/Elective</b>
<b>Max. Marks: 100</b> <b>External Exam: 75</b> <b>Internal Assessment: 25</b>	<b>Min. Passing Marks: 33</b>

**Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0**

Unit	Topic	No. of Lectures
<b>Unit I</b>	<b>Analysis of wave motion</b> Characteristics, Differential equation of a wave motion, principle of superposition, Interference, Beats, stationary waves, Energy of stationary waves, Wave velocity and group velocity, Fourier theorem, Fourier analysis of square, triangular and saw-tooth waves. Energy density of plane acoustic waves, Acoustic intensity, Measurement of acoustic intensity – the dB scale, Characteristics and loudness of Musical sound, Acoustic impedance, Reflection and transmission of acoustic waves. Acoustics of buildings, reverberation time, Sabine’s formula, Principle of sonar system.	<b>15</b>
<b>Unit II</b>	<b>Ultrasonics</b> Classification of Sound waves, Ultrasonics, Quartz crystal and Piezo electric effect, Magnetostriction effect, Properties of Ultrasonic, Detection of ultrasonic waves, Determination of velocity of ultrasonic waves in liquid (Acoustic grating method) . Application of Ultrasonics.	<b>15</b>
<b>Unit III</b>	<b>Simple Harmonic Oscillations</b> Periodic motion, SHM in mechanical systems, Energy of Simple harmonic oscillator, Superposition of SHM(s), Oscillations of two masses connected by a spring, Non-linear (An-harmonic) oscillator and its applications to simple pendulum. Applications of Simple harmonic motion in compound pendulum, Torsional pendulum and LC circuit, Composition of two SHM(s) of different frequency ratio, Lissajous’ figures for equal frequencies ratio and 2:1 frequencies ratio	<b>15</b>
<b>Unit IV</b>	<b>Damped and Forced Harmonic Oscillations</b> Damping force, Different cases for over, critical and under damping, Mechanical damped harmonic oscillators, Logarithmic decrement, Power Dissipation, Relaxation time & Quality Factor.	<b>15</b>

	Forced oscillations, Mechanical driven harmonic oscillators, Transient and steady state behavior, Power absorption, phenomenon of resonance, amplitude resonance, velocity resonance, sharpness of resonance/Fidelity, Bandwidth and quality factor.	
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### **Suggested Reading**

1. R. Resnick and D. Halliday: Physics Vol-I
2. D. S. Mathur: Mechanics
3. Brijlal and Subrahmanyam: Waves and Oscillations
4. B. S. Semwal and M. S. Panwar: Wave Phenomena and Material Science
5. Berkeley Physics Course: Mechanics Vol-I
6. R. K. Ghose: The mathematics of waves and Vibrations
7. D. P. Khandelwal: Oscillations and Waves
8. I. I. Poin: Physics of Vibration
9. A. P. French: Vibrations and Waves

### **Suggested Online Link:**

1. MIT Open Learning - Massachusetts Institute of Technology, <https://openlearning.mit.edu/>
2. National Programme on Technology Enhanced Learning (NPTEL), <https://www.youtube.com/user/nptelhrd>
3. Swayam Prabha - DTH Channel, [https://www.swayamprabha.gov.in/index.php/program/current\\_he/8](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

### **Suggested Continuous Evaluation (25 Marks):**

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

#### **Class Test/Assignment (25 marks)**

<b>CERTIFICATE COURSE IN BASIC PHYSICS</b>		
<b>Programme:</b> <i>Certificate Course in Basic Physics</i>		<b>Year:</b> I
<b>Semester:</b> I/II		
<b>Subject: Physics</b>		
<b>Course Code:</b>	<b>Course Title: Basic Electricity and Magnetism</b>	

<b>Credits: 04</b>		<b>Minor/Elective</b>
<b>Max. Marks: 100</b> <b>External Exam: 75</b> <b>Internal Assessment: 25</b>		<b>Min. Passing Marks: 33</b>
<b>Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0</b>		
<b>Unit</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>Unit I</b>	<b>Electrostatics:</b> Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere.	<b>15</b>
<b>Unit II</b>	<b>Magnetism</b> Magnetostatics: Biot-Savart's law and its applications- straight conductor circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para- and ferromagnetic materials.	<b>15</b>
<b>Unit III</b>	<b>Electromagnetic Induction and Alternating Current</b> Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field. Basic concepts of alternating currents.	<b>15</b>
<b>Unit IV</b>	<b>Maxwell's equations and Electromagnetic wave propagation</b> Equation of continuity, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave and its transverse nature.	<b>15</b>

### **Suggested Reading**

1. Edward M. Purcell: Electricity and Magnetism
2. J. H. Fewkes & J. Yarwood: Electricity & Magnetism, Vol. I
3. D. C. Tayal: Electricity and Magnetism

4. Ronald Lane Reese: University Physics
5. D. J. Griffiths: Introduction to Electrodynamics, 3rd Edn.
6. B. L. Flint & H. T. Worsnop: Advanced Practical Physics for Students
7. M. Nelson and J. M. Ogborn: Advanced level Physics Practicals, 4th Ed
8. I. Prakash & Ramakrishna: A Text Book of Practical Physics, 11th Ed
9. S. Panigrahi & B. Mallick: Engineering Practical Physics

**Suggested Online Link:**

1. MIT Open Learning - Massachusetts Institute of Technology,  
<https://openlearning.mit.edu/>
2. National Programme on Technology Enhanced Learning (NPTEL),  
<https://www.youtube.com/user/nptelhrd>
3. Swayam Prabha - DTH Channel,  
[https://www.swayamprabha.gov.in/index.php/program/current\\_he/8](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

**Suggested Continuous Evaluation (25 Marks):**

Continuous internal evaluation shall be based on allotted assignment and class tests. The mark shall be as follows:

**Class Test/Assignment (25 marks)**

## Theory and Practical Examination Pattern

Theory (External) each theory paper carrying **maximum marks 75** and shall consist of two sections A and B. Examination duration shall be 02 hours.

- Section A: Multiple choice questions (MCQ)/true and false/very very short answer type questions.  
Section A will consist of 10 questions, each of one mark)  
**Total: 10X1= 10 Marks**
- Section B: (Short answers type , 200 words)  
Section B will consist of 08 questions, each of 7 marks in which 5 has to be answered.  
**Total: 7X5= 35 Marks**
- Section C: (Long answers type, 500 words)  
Section C will consist of 3 long answered questions, in which has to be answered, each of 15 marks.  
**Total: 2X15= 30 marks**

For each theory paper internal assessment shall be conducted periodically (in the form of class tests and/or assignments/ group discussion/ oral presentation/ overall performance) during the semester period. Total marks allotted to internal assessment shall be 25 (Assignments 10 marks, written test/viva 10 marks and regularity 5 marks). The evaluated answer sheets/assignments have to be retained by the Professor In-Charge for the period of six months and can be shown to the students if students want to see the evaluated answer sheets. The marks obtained by the students shall be submitted to the Head of concerned department/ the Principal of the College for uploading onto the University examination portal.

**Practical** The laboratory work of the students has to be evaluated periodically.

The internal assessment (in the form of lab test, lab record, internal evaluation, assignment/home assignment and attendance) of total 10 marks for each semester shall be conducted during the semester. All kinds of exercises have to be conducted during a semester. Maximum 5 marks of attendance can be given to the students.

In each semester practical examination of 40 marks has to be conducted by two examiners (External and internal) having duration of 4 hours. The total number of students to be examined per batch should not be more than sixty. Marks obtained in the practical examination have to be submitted to the Head of the department/ Principal of the College. The Head of the Department/Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, Sri Dev Suman Uttarakhand University, Badshahithaul, New Tehri.

The breakup of marks for practical examination for each semester would be as follows:

Practical exam:	30 Marks (exercises)
Viva voce:	05 Marks
Lab Record and collection:	05 Marks
Sessional (Internal):	10 Marks
Total:	<b>50 marks (each semester)</b>

*Practical*  
10/15

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**Department of Botany  
Sri Dev Suman Uttarakhand University  
Badshahithaul, Tehri Garhwal**



**SYLLABUS  
of  
BOTANY  
for  
First Three Years of Higher Education  
*UG - BOTANY SYLLABUS*  
(Under National Education Policy-2020)**

**2022**



Semester-wise Titles of the Papers in B. Sc (Botany)					
Year	Semester	Course Code	Paper title	Theory/ Practical	Credits
<b>Certificate Course in Basic Botany</b>					
First Year	I	BOT101T	Microbes, Algae, Fungi and Bryophytes	Theory	4
		BOT102P	Practical/Lab course	Practical	2
	II	BOT201T	Pteridophytes, Gymnosperms and Angiosperms	Theory	4
		BOT202P	Practical/Lab course	Practical	2
<b>Diploma Course in Developmental Botany</b>					
Second Year	III	BOT301T	Morphology and Anatomy	Theory	4
		BOT302P	Practical/Lab course	Practical	2
	IV	BOT401T	Embryology and Cytogenetics	Theory	4
		BOT402P	Practical/Lab course	Practical	2
<b>Bachelor of Science</b>					
Third Year	V	BOT501T	Molecular Biology and Plant Biotechnology	Theory	4
		BOT502T	Economic Botany and Plant Breeding	Theory	4
		BOT503 P	Practical/Lab course	Practical	2
		BOT504R	Project I-Local Plant Diversity	Practical	4
	VI	BOT 601T	Physiology and Biochemistry	Theory	4
		BOT602T	Ecology and Biostatistics	Theory	4
		BOT603P	Practical/Lab course	Practical	2
			Project II-Local Ecosystem studies	Practical	4

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10/08/2020

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**Year wise Structure of B.Sc. in Botany (Core/elective courses and Projects)**

<b>Subject: Botany</b>											
Course/ Entry-Exit level	Year	Semester	Paper-1	Credits/hrs	Paper-2	Credits/ hrs	Paper-3	Credits/hrs	Research project	Credits /hrs	Total Credits/hrs
Certificate Course in Basic Botany	I	I	Microbes, Algae, Fungi and Bryophytes	4/60	Practical/ Lab course	2/60	-	-	-	-	6/120
		II	Pteridophytes, Gymnosperms and Angiosperms	4/60	Practical/ Lab course	2/60	-	-	-	-	6/120
Diploma Course in Developmental Botany	II	III	Morphology and Anatomy	4/60	Practical/ Lab course	2/60	-	-	-	-	6/120
		IV	Embryology and Cytogenetics	4/60	Practical/ Lab course	2/60	-	-	-	-	6/120
Bachelor of Science	III	V	Molecular Biology and Plant Biotechnology	4/60	Economic Botany and Plant Breeding	4/60	Practical /Lab course	2/60	Project-I	4/60	14/240
		VI	Physiology and Biochemistry	4/60	Ecology and Biostatistics	4/60	Practical /Lab course	2/60	Project-II	4/60	14/240

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## COURSE INTRODUCTION

The new curriculum of B.Sc. in Science (Botany) offers essential knowledge and technical skills to study plants in a holistic manner. Students would be trained in all areas of plant biology using a unique combination of core, elective and vocational papers with significant inter-disciplinary components. Students would be exposed to cutting-edge technologies that are currently being used in the study of plant life forms, their evolution and interactions with other organisms within the ecosystem. Students would also become aware of the social and environmental significance of plants and their relevance to the national economy.

B.Sc. Botany Programme covers academic activities within the classroom sessions along with practical concepts at laboratory sessions. Infield, outstation activities and projects would also be organized for real-life experience and learning. Candidates who have curiosity in plants kingdom, ecosystem, love exploring exotic places and wish to work as researchers or professions like Botanist, Conservationist, Ecologist, etc. can choose B.Sc. Botany course.

### Programme outcomes (POs):

Transformed curriculum shall develop educated outcome-oriented candidature, fostered with discovery- learning, equipped with practice & skills to deal practical problems and versed with recent pedagogical trends in education including e-learning, flipped class and hybrid learning to develop into responsible citizen for nation-building and transforming the country towards the future with their knowledge gained in the field of plant science.

PO1	CBCS syllabus with a combination of general and specialized education shall introduce the concepts of breadth and depth in learning.
PO2	Shall produce competent plant biologists who can employ and implement their gained knowledge in basic and applied aspects that will profoundly influence the prevailing paradigm of agriculture, industry, healthcare and environment to provide sustainable development.
PO3	Will increase the ability of critical thinking, development of scientific attitude, handling of problems and generating solutions, improve practical skills, enhance communication skill, social interaction, and increase awareness in judicious use of plant resources by recognizing the ethical value system.
PO4	The training provided to the students will make them competent enough for doing jobs in Govt. and private sectors of academia, research and industry along with graduate preparation for national as well as international competitive examinations, especially UGC-CSIR NET, UPSC Civil Services Examination, IFS, NSC, FCI, BSI, FRI etc.

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PO5	Certificate and diploma courses are framed to generate self- entrepreneurship and self- employability, if multi exit option is opted.
PO6	Lifelong learning is achieved by drawing attention to the vast world of knowledge of plants and their domestication.

**Programme specific objectives (PSOs): B.Sc. I Year Certificate Course in Basic Botany**

- This certificate course will provide knowledge on various fields of basic Botany.
- The syllabus is prepared to enable students for competitive exams in frontier areas of plant sciences.
- Students will be able to know about habit, habitat, morphology, anatomy and reproduction of various plant groups.

**Programme specific outcomes (PSOs): B.Sc. II Year/ Diploma Course in Developmental Botany**

- This programme will provide knowledge on plant anatomy, embryology and cytogenetics.
- Laboratory sessions following theory will provide easy understanding of internal structure of various plant parts, structural organization, reproductive biology and genetics.
- This course will help students to become a plant morphologist.

**Programme specific outcomes (PSOs): B.Sc. III Year/ Bachelor of Science**

- The three year learning outcome of graduation will provide understanding of plant systematic, developmental biology, ecology, statistics, physiology, biochemistry, anatomy, and plant genetics.
- It will provide expertise in conservation biology and reproduction biology.
- After completing this course successfully students will be able to contribute in the field of plant sciences. The research project will help to develop research aptitude for higher education and scientific research.

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**DETAILED SYLLABUS OF B.Sc. I YEAR FOR CERTIFICATE COURSE IN BASIC BOTANY**

Course	Year	Semester
<i>Certificate Course in Basic Botany</i>	<i>B.Sc. I</i>	<i>I</i>

**Paper 1: Microbes, Algae, Fungi and Bryophytes (Course code: BOT101T) Credit: 4**

**Course Outcome**

After the completion of the course the students will be able to:

1. Develop understanding about the classification and diversity of different microbes including viruses, Algae, Fungi & Lichens & their economic importance.
2. Develop conceptual skill about identifying microbes, pathogens, biofertilizers & lichens.
3. Gain knowledge about developing commercial enterprise of microbial products.
4. Learn host –pathogen relationship and disease management.
5. Gain Knowledge about uses of microbes in various fields.
6. Understand the structure and reproduction of certain selected bacteria algae, fungi and lichens
7. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes.

Unit	Topic	No. of lectures/ hrs (60)
1	<b>Microbes :</b> Viruses-discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); economic importance; bacteria–discovery, general characteristics and cell structure; reproduction–vegetative, asexual and recombination (conjugation, transformation and transduction); economic importance.	15
2	<b>Algae:</b> General characteristics; Range of thallus organization and reproduction; classification of algae; morphology and life-cycles of: <i>Nostoc</i> , <i>Chlamydomonas</i> , <i>Oedogonium</i> , <i>Vaucheria</i> , <i>Fucus</i> , <i>Sargassum</i> ; economic importance of algae.	15
3	<b>Fungi :</b> Introduction-general characteristics, ecology and significance, range of somatic thallus organization, cell wall composition, nutrition, reproduction and classification (G.C. Ainsworth); life cycle of <i>Stemonitis</i> (Myxomycota)	15

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	<i>Rhizopus</i> (Zygomycota) <i>Penicillium</i> (Ascomycota), <i>Puccinia</i> , <i>Agaricus</i> (Basidiomycota); <i>Alternaria</i> (Deutromycota), Symbiotic associations: Lichens- General account, reproduction and significance; Mycorrhiza: ectomycorrhiza, endomycorrhiza and their significance.	
4	<b>Bryophytes:</b> General characteristics, adaptations to land habit, classification (up to family), morphology, anatomy and reproduction of <i>Riccia</i> , <i>Marchantia</i> and <i>Funaria</i> ; ecology and economic importance of bryophytes.	15

### Suggested reading

- Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
- Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
- Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
- Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
- Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi, India.
- Pandey, S.N and Trivedi, P.S. (2015). A text book of Botany Vol.I Vikas publishing House Pvt/ Ltd, New Delhi.
- Vashishta, P.C., Sinha, A.K., Kumar, A. (2010). Bryophyta, S. Chand. Delhi, India.
- Parihar, N.S. (1991). An Introduction to Embryophyta Vol. I Bryophyta. Central Book Depot, Allahabad.

Paper 2: Practical/ Lab course (Course code: BOT102P)

Credit: 2

### Course Outcome

After the completion of the course the students will be able:

1. Understand the instruments, techniques, lab etiquettes and good lab practices for working in a microbiology laboratory.
2. Develop skills for identifying microbes and using them for Industrial, Agriculture and Environment purposes.
3. Practical skills in the field and laboratory experiments in Microbiology and Pathology.
4. Learn to identify algae, lichens and plant pathogens along with their symbiotic and parasitic associations.
5. Students would learn to create their small digital reports where they can capture the zoomed in and zoomed out pictures as well as videos in case they are able to find some rare structure or phenomenon related to Bryophytes.

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6. Understand morphology, anatomy, reproduction and developmental changes therein through typological study and create a knowledge base in understanding diversity, economic values & taxonomy of bryophytes.

Unit	Topic	No. of Lectures/ hrs (60)
1	EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle. Types of Bacteria from temporary/permanent slides/photographs; EM of bacterium; Binary Fission; Conjugation; Structure of root nodule; Gram staining technique	15
2	Study of vegetative and reproductive structures of <i>Nostoc</i> , <i>Chlamydomonas</i> (electron micrographs), <i>Oedogonium</i> , <i>Vaucheria</i> , <i>Fucus</i> and <i>Sargassum</i> through temporary preparations and permanent slides/specimens	15
3	<i>Rhizopus</i> and <i>Penicillium</i> : Asexual stages from temporary mounts. <i>Alternaria</i> : Specimens/photographs and tease mounts. <i>Puccinia</i> : Herbarium specimens of Black Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on wheat and permanent slides of both the hosts. <i>Agaricus</i> : Specimens of button stage and full grown mushroom. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose). Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs).	15
4	<i>Marchantia</i> and <i>Riccia</i> : Morphology of thallus, rhizoids and scales, V.S. thallus through gemma cup, gemmae whole mount (all temporary slides), V.S antheridiophore, archegoniophore, L.S. sporophyte (all permanent slides). <i>Funaria</i> - Morphology, whole mount leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, L.S capsule and protonema.	15

#### Suggested reading

- Pandey, B.P. (2014). Modern Practical Botany Vol. I. S. Chand and Company Ltd. Ramnagar, New Delhi.
- Purohit, S.D., Kundra, G. K. and Singhvi, A. (2013). Practical Botany (part I). Apex Publishing House Durga Nursery Road Udaipur, Rajasthan.
- Sambamurty, A.V.S.S. (2006). A text book of algae. I.K International Publishing House, Pvt. Ltd.

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Course	Year	Semester
<i>Certificate Course in Basic Botany</i>	<i>B.Sc. I</i>	<i>II</i>

**Paper 1: Pteridophytes, Gymnosperms and Angiosperms (BOT201T) Credit: 4**

**Course Outcome**

After the completion of the course the students will be able to:

1. Develop critical understanding on morphology, anatomy and reproduction of Pteridophytes, Gymnosperms and Angiosperms.
2. Understanding of plant evolution and their transition to land habitat.
3. To learn the major patterns of diversity among plants, and the characters and types of data used to classify plants.
4. To compare the different approaches to classification with regard to the analysis of data.
5. To become familiar with major taxa and their identifying characteristics, and to develop in depth knowledge of the current taxonomy of a major plant family.
6. To discover and use diverse taxonomic resources, reference materials, herbarium collections, publications.

Unit	Topic	No. of Lectures/ hrs (60)
1	<b>Pteridophytes</b> General characteristics, classification, early land plants ( <i>Rhynia</i> ); classification (up to family), morphology, anatomy and reproduction of <i>Selaginella</i> , <i>Equisetum</i> and <i>Pteris</i> ; heterospory and seed habit, stelar evolution; ecological and economic importance of Pteridophytes.	15
2	<b>Gymnosperms</b> General characteristics, classification (up to family), morphology, anatomy and reproduction of <i>Cycas</i> , <i>Pinus</i> and <i>Ephedra</i> ; ecological and economic importance.	15
3	<b>Introduction to plant taxonomy</b> Identification, classification, nomenclature, functions of herbarium, important herbaria and botanical gardens of the world and India Important flora, botanical nomenclature (principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations). Classification: Types of classification-artificial, natural and phylogenetic Bentham and Hooker (upto series) and Hutchinson classification.	10
4	<b>Taxonomy of plant families</b>	20

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Ranunculaceae, Malvaceae, Rutaceae, Fabaceae, Apiaceae, Solanaceae, Lamiaceae, Euphorbiaceae, Asteraceae, Poaceae and Orchidaceae (Families can be chosen as per availability of local flora)	
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### Suggested readings

- Vashishta, P.C., Sinha, A.K. and Kumar, A. (2010). Pteridophyta, S Chand and Company Ltd., Ramnagar, New Delhi, India.
- Vashishta, P.C., Sinha, A.K. and Kumar, A. (2010). Gymnosperms, S Chand and Company Ltd., Ramnagar, New Delhi, India.
- Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
- Parihar, N.S. (1991). An Introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
- Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.
- Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford and IBH Pvt. Ltd., New Delhi. 3<sup>rd</sup> edition.
- Gangulee H.C., Kar, A.K. and Santra S.C. (2011). College Botany Vol II. 4<sup>th</sup> Edition New Central Book Agency.
- Parihar, N.S. (1976). Biology and Morphology of Pteridophytes. Central Book Depot.
- Sharma, O.P. (1990). Textbook of Pteridophyta. MacMillan India Ltd. Delhi.
- Pandey, B.P. (2010). College Botany Vol II. S. Chand and Company Ltd., New Delhi, India.

**Paper 2: Practical/ Lab course (BOT202P)**

**Credit: 2**

### Course outcomes:

1. The students will be made aware of the group of plants that have given rise to land habit and the flowering plants. Through field study they will be able to see these plants growing in nature and become familiar with the biodiversity.
2. Develop an understanding by observation and table study of representative members of phylogenetically important groups to learn the process of evolution in a broad sense.
3. Understand morphology, reproduction and developmental changes therein through typological study and create a knowledge base in understanding the basis of plant diversity, economic values & taxonomy of plants.

Unit	Topic	No. of Lectures/ hrs (60)
1	<i>Selaginella</i> : Morphology, whole mount leaf with ligule, strobilus, microsporophyll and megasporophyll (temporary slides), T.S. stem, L.S. strobilus (permanent slide). <i>Equisetum</i> : Morphology, T.S. internode, L.S. strobilus, T.S and L.S.	15

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	strobilus, whole mount sporangiophore, spores (wet and dry) (temporary slides); T.S. rhizome (permanent slide). <i>Pteris</i> : Morphology, T.S. rachis, V.S. sporophyll, whole mount sporangium and spores (temporary slides), T.S. rhizome, whole mount prothallus with sex organs and young sporophyte (permanent slide).	
2	<i>Cycas</i> : Morphology (coralloid roots, bulbil, leaf), T.S. coralloid root and rachis, V.S. leaflet and microsporophyll, whole mount spores (temporary slides), L.S. ovule, T.S. root (permanent slide). <i>Pinus</i> : Morphology (long and dwarf shoots, male and female cones), T.S. needle and stem, L.S./T.S. male cone, whole mount microsporophyll and microspores (temporary slides), L.S. female cone, TLS and RLS stem (permanent slide).	15
3	<b>Taxonomic Identification:</b> Description of an angiospermic plant, study of vegetative and floral characters (description, V.S. flower, section of ovary, floral diagram/s, floral formula/e) and systematic position of the following families according to Bentham and Hooker's system of classification: Brassicaceae, Asteraceae, Solanaceae, Lamiaceae, and Liliaceae. <b>(Plants can be chosen as per availability of local flora)</b>	20
4	<b>Herbarium techniques:</b> Plant collection, preservation and mounting of two properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book), digital/virtual herbarium.	10

#### Suggested readings

- Pandey, B.P. (2014). Modern Practical Botany Vol. II. S. Chand and Company Ltd., New Delhi.
- Bendre, A.M. and Kumar A. (2003). Manual of Practical Botany Vol. II. Rastogi Publications, Meerut.
- Santra S.C. and Chatterjee (2005). College Botany Practical Vol. II New Central Book Agency Pvt. Ltd.

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**DETAILED SYLLABUS OF B.Sc. II YEAR OR DIPLOMA COURSE IN  
DEVELOPMENTAL BOTANY**

Course	Year	Semester
<i>Diploma Course in Developmental Botany</i>	<i>B.Sc. II</i>	<i>III</i>

**Paper 1: Morphology and Anatomy (Course code: BOT301T) Credit: 4**

**Course outcomes:**

1. Understand morphology and anatomy.
2. Understand role of tissues in plant functions.
3. Understand the composition, modifications, internal structure & architecture of plants.

Unit	Topic	No. of Lectures/ hrs (60)
1	<b>Meristematic and permanent tissues:</b> Types of tissues, Root and shoot apical meristems, Theories related to apical meristem, simple, complex and secretory tissues	15
2	<b>Organs:</b> Structure of dicot and monocot root, stem and leaf, root stem transition	15
3	<b>Adaptive and protective systems:</b> Epidermis, cuticle and stomata	15
4	<b>Secondary growth:</b> Structure and function of Vascular cambium, secondary growth in stem and roots, abnormal secondary growth	15

**Suggested readings**

- Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.
- Pandey, B.P. (2001) Plant Anatomy. S. Chand and Company Ltd., New Delhi.
- Sharma, P.C. (2017). Text Book of Plant Anatomy. Arjun Publishing House.
- Menan, A.B. (2008). Introduction to Plant Anatomy. Neha Publishers and Distributors.
- Sharma, M.K. (2013) Plant Structures (An Introduction to Plant Anatomy). Vayu Education of India.

**Paper 2: Practical/Lab Course (Course code: BOT302P) Credits: 02**

**Course outcomes:**

1. Understand cell structure in monocot and dicot plants.
2. Understand cell structure, secondary growth and adaptive anatomy in plants.

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Unit	Topic	No. of Lectures (60 hrs)
1	Study of meristems through permanent slides and photographs. Tissues (parenchyma, collenchyma and sclerenchyma), complex and secretory tissues	15
2	Anatomy of monocot and dicot Stem; monocot and dicot leaf; monocot and dicot root ( <b>Plants can be chosen as per availability of local flora</b> )	15
3	Adaptive anatomy: Xerophytes, Hydrophytes, Epiphytes ( <b>Plants can be chosen as per availability of local flora</b> )	15
4	Normal and abnormal secondary growth in different plants ( <b>Plants can be chosen as per availability of local flora</b> )	15

#### Suggested readings

- Pandey, B.P. (2014). Modern Practical Botany Vol. II. S. Chand and Company Ltd. Ramnagar, New Delhi.
- Pandey, B.P. (2001). Plant Anatomy. S. Chand and Company Ltd., Ram Nagar, New Delhi.
- Sundara, R.S. (2002). Practical Manual Anatomy and Embryology. Anmol Publisher, New Delhi.

Course	Year	Semester
<i>Diploma Course in Developmental Botany</i>	<i>B.Sc. II</i>	<i>IV</i>

**Paper 1: Embryology and Cytogenetics (course code: BOT401) Credit: 4**

#### Course outcomes:

1. Understand reproduction and developmental changes in plants.
2. Understand the structure and chemical composition of chromatin and concept of cell division.
3. Interpret the Mendel's principles; acquire knowledge on cytoplasmic inheritance and sex-linked inheritance.

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Unit	Topic	No. of Lectures (60 hrs)
1	<b>Pollination and fertilization:</b> Pollination mechanisms and adaptation, structure of anther and pollen, development of male and female gametophytes, double fertilization.	15
2	<b>Embryo and endosperm:</b> Types of ovules and embryo sacs; embryo and endosperm; types of endosperm; dicot and monocot embryo; apomixis and polyembryony.	15
3	<b>Heredity:</b> (Pre-mendelian genetics, brief life history of Mendel, laws of Inheritance, modified mendelian ratios, lethal genes, co-dominance, incomplete dominance, chi square, pedigree analysis, multiple allelism, chromosome theory of inheritance, sex-determination and sex-linked inheritance, cytoplasmic inheritance <b>Linkage and crossing over:</b> Linkage: concept and history, complete and incomplete linkage, bridges experiment, coupling and repulsion, recombination frequency, linkage maps based on two and three factor crosses.	15
4	<b>Crossing over:</b> Concept and significance, cytological proof of crossing over; mutations and chromosomal aberrations (types of mutations, effects of physical and chemical mutagens, numerical chromosomal changes: euploidy, polyploidy and aneuploidy; structural chromosomal changes: deletions, duplications, inversions and translocations).	15

#### Suggested readings

- Bhojwani, S.S. and Bhatnagar, S.P. (2010). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
- Johri, B.M. (1984). Embryology of Angiosperms. Springer-Verlag, Berlin
- Maheshwari, P. (1971). An Introduction to Embryology of Angiosperms. McGraw Hill Book Co. London.
- Rastogi, V.B. (2019). Genetics. 4<sup>th</sup> Edition. MEDTECH: A Division of Scientific International.

**Paper 2: Practical/Lab Course (Course code: BOT402) Credits: 4**

#### Course outcomes

1. Understand the pollination and seed dispersal mechanism.
2. Study the structure of ovules and female gametophytes.
3. Interpret the Mendel's principles; and understand the monohybrid and dihybrid crosses and their ratio and chromosomal changes.

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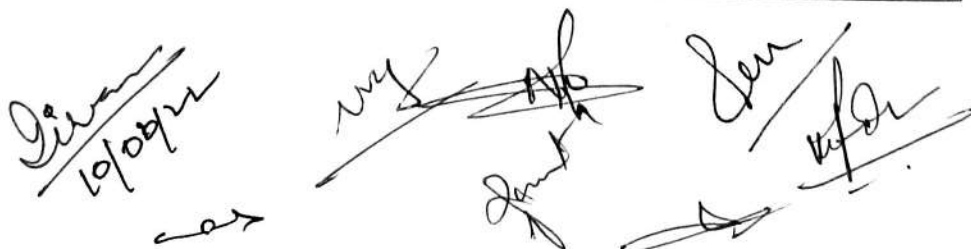
Unit	Topic	No. of Lectures (60 hrs)
1	Pollination types and seed dispersal mechanisms (photographs and specimens)	15
2	Structure of anther (young and mature). Types of ovules: anatropous, orthotropous, circinotropous, amphitropous, campylotropous. Female gametophyte: <i>Polygonum</i> (monosporic) type of embryo sac development (permanent slides/photographs) Ultrastructure of mature egg apparatus cells through electron micrographs (permanent slides/photographs)	15
3	Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square. Monohybrid cross (dominance and incomplete dominance) Dihybrid cross and gene interactions Pedigree analysis for dominant and recessive autosomal and sex linked traits. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).	15
4	Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes through photographs. Photographs/permanent slides showing translocation ring, laggards and inversion bridge	15

#### Suggested reading

- Sundara, R.S. (2002). Practical Manual Anatomy and Embryology. Anmol Publisher, New Delhi.
- Singh, R.J. (2021). Practical Manual on Plant Cytogenetics. CRC Press, Taylor and Francis Group, Routledge.

#### DETAILED SYLLABUS OF B. Sc III YEAR OR BACHELOR OF SCIENCE

Course	Year	Semester
<i>Bachelor of Science</i>	<i>B.Sc. III</i>	<i>V</i>


  
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**Paper 1: Cell and Molecular Biology, and Biotechnology (Course code: BOT501T)Credit: 4**

**Course outcomes:**

1. Understand cell structure, nucleic acids, organization of DNA in prokaryotes and Eukaryotes, DNA replication mechanism, genetic code and transcription process.
2. Know about processing and modification of RNA and translation process, function and regulation of expression.
3. Understand the basic tools and techniques used in Plant tissue culture.

Unit	Topic	No. of Lectures (60 hrs)
1	<b>Cell Biology:</b> The cell theories, prokaryotic and eukaryotic cells, cell organelles (Mitochondria, Chloroplast, ER, golgi body, lysosomes, peroxisomes, glyoxisomes, nucleus, chromatin; DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure), cell membrane and cell wall; models of membrane structure, cell cycle (overview of cell cycle, mitosis and meiosis, molecular controls).	18
2	<b>Molecular Biology:</b> Genetic material (DNA: Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase bacteriophage experiment, DNA structure, types of DNA, types of genetic material); DNA replication (Prokaryotes); Transcription (Prokaryotes) Types of structures of RNA (mRNA, tRNA, rRNA); Translation (Prokaryotes), Regulation of gene expression (Prokaryotes: Lac operon and Tryptophan operon).	18
3	<b>Plant tissue culture:</b> Culture types on the basis of explants and media composition, General lab setup and instrumentation, micropropagation, brief account of protoplast culture, somatic embryogenesis with their applications.	12
4	<b>Recombinant DNA techniques:</b> Blotting techniques: Northern, Southern and Western Blotting, Molecular DNA markers i.e. RAPD, RFLP, SNPs, PCR, hybridoma and monoclonal antibodies, ELISA and Immunodetection.	12

**Suggested readings**

- Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley and Sons. Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
- Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.

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- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G.P. (2009). The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

**Paper 2: Economic Botany and Plant Breeding (Course code: BOT502T) Credit:4**

**Course outcomes**

1. Know about the importance of medicinal plants and its useful parts, economically important plants in our daily life and also about the traditional medicines and herbs, and its relevance in modern times.
2. Understand the plant breeding systems and heterosis and mutation in plant breeding.

Unit	Topic	No. of Lectures (60 hrs)
1	Origin of cultivated plants (concept of centres of origin, their importance with reference to vavilov's work)	18
2	A brief knowledge of botany and commercial utilization and uses of the following plants: 1. Cereals and millets- Wheat, Rice and Maize, Ragi, Pearl millet 2. Sugar yielding plants- Sugarcane and Sugar beet 3. Fruits- Mango, Apple, Banana, Citrus and Litchi. 4. Fibers- Cotton, Jute, Hemp, Coir, Agave and Semal. 5. Vegetables- Root vegetables, stem vegetables and fruit vegetables. 6. Timbers- Teak, Shisham, Sal, Chir and Deodar. 7. Medicinal plants- <i>Aconitum</i> , <i>Atropa</i> , <i>Cinchona</i> , <i>Rauwolfia</i> , <i>Ephedra</i> , <i>Withania</i> , and <i>Alovera</i> . 8. Oils, Beverages, Fumitories, masticatories, Spices and Condiments yielding plants.	12
3	Plant breeding (introduction and objectives; breeding systems, important achievements and undesirable consequences of plant breeding); methods of crop improvement; centres of origin and domestication of crop plants, plant genetic resources; acclimatization; selection methods.	18
4	Hybridization: for self, cross and vegetatively propagated plants – procedure, advantages and limitations; inbreeding depression and heterosis (history, genetic basis of inbreeding depression and heterosis; applications); crop improvement and breeding (role of mutations; polyploidy; distant hybridization and role of biotechnology in crop improvement).	12

**Suggested readings**

- Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
- Pandey, B.P. (1999). Economic Botany. S. Chand, New Delhi.

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- Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7<sup>th</sup> edition.
- Acquaah, G. (2007). Principles of Plant Genetics and Breeding. Blackwell Publishing.

**Paper 3: Lab Course (Course code: BOT503P) Credit: 2**

**Course outcomes**

1. Learn the basic structure and function of cells and instruments used in molecular biology,
2. Know about the commercial products produced from plants.
3. Understand about the ethnobotanical details of plants.
4. Learn about the chemistry of plants and herbal preparations.

Unit	Topic	No. of Lectures (60 hrs)
1	Structure of prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs. Study of the photomicrographs of cell organelles, structure of plant cell through temporary mounts. Study of mitosis and meiosis (temporary mounts and permanent slides). Demonstration of the effect of temperature, organic solvent on semi permeable membrane. Study of plasmolysis, deplasmolysis, Endo- and Exo-osmosis.	15
2	Instruments and equipments used in molecular biology The cell size measurements (either length or breadth/diameter) by micrometry. Study the structure of nuclear pore complex by photograph (from Gerald Karp) Study of special chromosomes (polytene and lampbrush) either by slides or photographs. Study DNA packaging by micrographs. Preparation of the karyotype and ideogram from given photograph of somatic metaphase chromosome.	15
3	Study of economically important plants: Cereals: Wheat, Rice, Maize Millets: Finger millet, Foxtail, Ragi Pulses: Gram, Green gram, Pea, Pigeon pea, Soyabean, Chick pea Timbers: Shisam, Sal, Teak, Deodar, Pine Medicinal plants: Dhatura, Berginia, Hedychium, Poppy, Basil, Barberry Beverages: Tea, Coffee Oils: Mustard, Seseame, Coconut, Linseed, Groundnut, Castor, Laung, Sandal wood, Mentha Spices: Coriander, Cardmum, Curcuma, Cinamom, Laung, Cumin, Thyme, Nigella, Cinamom leaf	15

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	Fibers: Jute, Coconut, Hemp, Urtica, Cotton Sugars and starch yielding plants: Sugarcane, Potato, Beet root Fruits and vegetables cultivated in the area. Gums and Resins.	
4	Hybridization techniques - Emasculation, Bagging (For demonstration only). Induction of polyploidy in plants (For demonstration only).	15

**Suggested readings**

- Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
- Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
- Pandey, B.P. (1999). Economic Botany. S. Chand, New Delhi.

**Paper 4: Project in Botany for Pre-graduation (Course code: BOT504R) Credit: 4**

(Based on Local Plant Diversity)

Course	Year	Semester
<i>Bachelor of Science</i>	<i>B.Sc. III</i>	<i>VI</i>

**Paper 1: Plant Physiology and Biochemistry (BOT601T) Credit: 4**

**Course outcome**

1. Understand the role of physiological and metabolic processes for plant growth and development.
2. Learn the symptoms of mineral deficiency in crops and their management.
3. Assimilate knowledge about Biochemical constitution of plant diversity.
4. Know the role of plants in development of natural products, nutraceuticals, dietary supplements, antioxidants.

Unit	Topic	No. of Lectures (60 hrs)
1	<b>Plant-water relations:</b> Importance of water, water potential and its components; transpiration and its significance; factors affecting transpiration; root pressure and guttation. <b>Mineral nutrition:</b> Essential elements, macro and micronutrients; criteria of essentiality of elements; role of essential elements; transport of ions across cell membrane, active and passive transport, carriers, channels and Pumps	18
2	<b>Photosynthesis:</b> (photosynthetic Pigments (Chl a, b, xanthophylls,	18

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	carotene); photosystem I and II, electron transport and mechanism of ATP synthesis; C <sub>3</sub> , C <sub>4</sub> and CAM pathways of carbon fixation; photorespiration). <b>Respiration</b> (glycolysis, anaerobic respiration, TCA cycle; oxidative phosphorylation, glyoxylate cycle).	
3	<b>Nitrogen metabolism:</b> Biological nitrogen fixation; nitrate and ammonia assimilation. <b>Plant growth regulators:</b> Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.	12
4	<b>Biochemistry:</b> General introduction to carbohydrates, lipids and proteins. Enzymes (structure and properties; mechanism of enzyme catalysis and enzyme inhibition, factors affecting enzyme action).	12

### Suggested readings

- Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
- Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley and Sons, U.S.A. 4th Edition.
- Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

### Paper 2: Ecology and Biostatistics (Course code: BOT602T) Credit: 4

#### Course outcome

1. Acquaint the students with complex interrelationship between organisms and environment;
2. Make them understand methods for studying vegetation, community patterns and processes, ecosystem functions, and principles of phytogeography.
3. Understanding the strategies for sustainable natural resource management and biodiversity conservation.
4. Practical knowledge of the different statistics tools and techniques.

Unit	Topic	No. of Lectures (60 hrs)
1	<b>Ecological factors:</b> Soil (Origin, formation, composition, soil profile) <b>Plant adaptation</b> in relation to water (Hydrophytes and xerophytes), light (Sciophytes and heliophytes) and temperature Pollution: Water, Soil and Radioactive.	12

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2	<b>Ecosystem:</b> Types, structure, energy flow, trophic organization, food chains and food webs, ecological pyramids. <b>Biogeochemical cycles:</b> Cycling of carbon, nitrogen and phosphorous. <b>Population:</b> Characteristics, Growth curves, Ecotypes and Ecads <b>Plant communities:</b> Characteristics, plant succession, Biological spectrum <b>Biodiversity conservation</b>	18
3	<b>Biostatistics:</b> Definition and scope of statistics, sampling techniques, representation of data: tabular, graphical etc <b>Measures of central tendency:</b> Arithmetic mean, mode, median.	18
4	<b>Measures of dispersion:</b> range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit Regression analysis	12

#### Suggested reading

- Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
- Shukla, R.S. and Chandel P.S. (2005). A text book of Plant Ecology. S. Chand and Company Ltd., Ram Nagar, New Delhi.
- Rastogi, V.B. (2015). Biostatistics. Medtech, 3<sup>rd</sup> Edition.
- Banerjee, P.K. (2006). Introduction to Biostatistics. S. Chand and Company Ltd., Ram Nagar, New Delhi.
- Singh, J.S. Singh S.P. and Gupta, S.R. (2014). Ecology, Environment and Resource Conservation. S. Chand and Company Pvt. Ltd., New Delhi.

**Paper 3: Practical/lab Course (Course code: BOT603P)**

**Credit: 2**

#### Course outcome

1. Understand the role of different physiological and metabolic processes of plants.
2. Gaining practical knowledge implemented in the biodiversity assessment and conservation.
3. Practical knowledge of the different statistics tools and techniques.

Unit	Topic	No. of Lectures (60 hrs)
1	Demonstration of process of diffusion, osmosis and plasmolysis Demonstration of transpiration in dorsiventral leaf by four leaf and cobalt chloride method. Determination of rate of transpiration by Ganong's/Farm potometer.	18

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	Demonstration of the effect of light intensity and bicarbonate concentration on O <sub>2</sub> evolution in photosynthesis by Wilmott's bublar Determination of R.Q of different respiratory substrates by Ganong's respirometer Demonstration of anaerobic respiration in germinating seeds.	
2	Test of carbohydrates, proteins and fats.	12
3	Observation and study of different ecosystems mentioned in the syllabus. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, rain gauge and lux meter. Determination of pH, and analysis of soil samples for soil moisture, organic carbon, nitrogen and phosphorus. Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats. Study of ecological adaptations in hydrophytes and xerophytes. Study of biotic interactions of: stem parasite ( <i>Cuscuta</i> ), root parasite (orobanche), epiphytes, predation (insectivorous plants) through specimen or diagrams. Determination of minimum quadrat size for the study of herbaceous vegetation by species area curve method (species to be listed). Quantitative analysis of herbaceous vegetation in the college campus for frequency, density, abundance and A/F ratio. Population structure study of dominant tree species of the locality.	18
4	Analysis of statistical data: mean, median, and mode by analyzing the given data of individual, discrete and continuous series, standard error and deviation Numerical based on correlation coefficient Numerical based on chi square value Representation of data by making graphs and diagrams etc. Comment upon given graphs, diagrams etc.	12

### Suggested readings

- Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
- Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

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(Based on Local Ecosystem studies)

**Vocational/Skill Enhancement Courses in Botany**

**(i) Bio-fertilizers**

**Credit: 3**

**Course outcome**

1. Develop conceptual skill about identifying microbes, and bio-fertilizers.
2. Gain knowledge about developing commercial enterprise of bio-fertilizers.

Unit	Topic	No. of lecturers/ hrs (45)
1	General account about the microbes used as biofertilizer – <i>Rhizobium</i> – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.	10
2	<i>Azospirillum</i> : isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. <i>Azotobacter</i> : classification, characteristics – crop response to <i>Azotobacter</i> inoculum, maintenance and mass multiplication Cyanobacteria (blue green algae), <i>Azolla</i> and <i>Anabaena azollae</i> association, nitrogen fixation, factors affecting growth, blue green algae and <i>Azolla</i> in rice cultivation	15
3	Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop Plants	10
4	Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application. National and state institutes related to the activity.	10

**Suggested readings**

- Dubey, R.C. (2005). A Text Book of Biotechnology. S.Chand and Co, New Delhi.
- Kumaresan, V. (2005). Biotechnology, Saras Publications, New Delhi.

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- John Jothi Prakash, E. (2004). Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
- Sathe, T.V. (2004). Vermiculture and Organic Farming. Daya Publishers.
- Subha Rao, N.S. (2000). Soil Microbiology, Oxford and IBH Publishers, New Delhi.
- Vayas, S.C, Vayas, S. and Modi, H.A. (1998). Bio-fertilizers and organic Farming. Akta Prakashan, Nadiad.

**(ii) Herbal Technology**

**Credit: 3**

**Course outcome**

1. Develop conceptual skill about traditional Indian medicinal system, herbal medicines, their processing, storage and marketing.
2. Gain knowledge about developing commercial enterprise of herbal medicines.
3. Learn the basic tools and techniques for phytochemical analysis and propagation of the medicinal plants.

Unit	Topic	No. of lecturers/ hrs (45)
1	Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants.	10
2	Pharmacognosy - systematic position medicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka. Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; <i>Catharanthus roseus</i> (cardiotonic), <i>Withania somnifera</i> (drugs acting on nervous system), <i>Clerodendron phlomoides</i> (anti-rheumatic) and <i>Centella asiatica</i> (memory booster).	15
3	Analytical pharmacognosy: Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds).	10
4	Medicinal plant banks micro propagation of important species ( <i>Withania somnifera</i> , neem and tulsi- Herbal foods-future of pharmacognosy). National and state institutes related to the activity.	10

**Suggested readings**

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- Chopra, R.N., Nayar S.L. and Chopra, I.C. (1956). Glossary of Indian Medicinal Plants, C.S.I.R, New Delhi.
- Arber, A. (1999). Herbal plants and Drugs. Mangal Deep Publications.
- Sivarajan V.V. and Balachandran I. (1994). Ayurvedic drugs and their plant source. Oxford IBH publishing Co.
- Miller, L. and Miller, B. (1998). Ayurveda and Aromatherapy. Banarsidass, Delhi.
- Green, A. (2000). Principles of Ayurveda, Thomsons, London.
- Kokate, C.K. (1999). Pharmacognosy, Nirali Prakashan.

**(iii) Nursery and Gardening**

**Credit: 3**

1. Develop conceptual of nursery and gardening.
2. Gain knowledge about developing commercial enterprise of nursery.

Unit	Topic	No. of lecturers/ hrs (45)
1	Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants. Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy-Seed storage: Seed banks, factors affecting seed viability, genetic erosion – Seed production technology - seed testing and certification	15
2	Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants – green house - mist chamber, shed root, shade house and glass house	10
3	Gardening: definition, objectives and scope - different types of gardening-landscape and home gardening - parks and its components - plant materials and design-computer applications in landscaping - Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting.	10
4	Sowing/raising of seeds and seedlings - Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures. National and state institutes related to the activity.	10

**Suggested readings**

- Bose T.K. and Mukherjee, D. (1972). Gardening in India, Oxford and IBH Publishing Co., New Delhi.

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- Sandhu, M.K. (1989). Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
- Kumar, N. (1997). Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
- Agrawal, P.K. (1993). Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.
- Jules J. (1979). Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.

**(iv) Floriculture**

**Credit: 3**

**Course outcome**

1. Develop conceptual skill about floriculture.
2. Gain knowledge about developing commercial enterprise of commercial floriculture.

Unit	Topic	No. of lecturers/ hrs (45)
1	Introduction: History of gardening; Importance and scope of floriculture. Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Role of plant growth regulators.	15
2	Ornamental Plants: Flowering annuals; Herbaceous perennials; Shade and ornamental trees; Cacti and succulents; Palms and Cycads; Ferns; Cultivation of plants in pots; Indoor gardening; Bonsai.	10
3	Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India.	10
4	Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold, Rose, Lilium, Orchids). Diseases and Pests of Ornamental Plants. National and state institutes related to the activity.	10

**Suggested readings**

- Randhawa, G.S. and Mukhopadhyay, A. (1986). Floriculture in India. Allied Publishers.

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**(v) Medicinal Botany****Credit: 3****Course outcome**

1. Understand the traditional Indian medicinal systems and their importance.
2. To learn the strategies for the conservation of medicinal plants.
3. Gain knowledge about developing commercial enterprise of herbal medicines.

<b>Unit</b>	<b>Topic</b>	<b>No. of lecturers/ hrs (45)</b>
1	History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; Definition and Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments, Siddha:	10
2	Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e- tabiya, tumors treatments/ therapy, polyherbal formulations.	10
3	Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanical Gardens, Ethnomedicinal plant Gardens. Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding	15
4	Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany. folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases. National and state institutes related to the activity.	10

**Suggested readings**

- Trivedi, P.C. (2006). Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
- Purohit, S.S. and Vyas, S.P. (2008). Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios, India.

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(vi) Conservation and Management of biodiversity

Credit: 3

Course outcome

1. Understand the importance, benefits and services of biodiversity.
2. To learn the strategies for the conservation of biodiversity.

Unit	Topic	No. of lecturers/ hrs (45)
1	Plant diversity and its scope- Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agrobiodiversity and cultivated plant taxa, wild taxa. Values and uses of Biodiversity: Ethical and aesthetic values, Precautionary principle, Methodologies for valuation, Uses of plants, Uses of microbes	10
2	<b>Loss of Biodiversity;</b> Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Projected scenario for biodiversity loss, <b>Management of Plant Biodiversity:</b> Organizations associated with biodiversity management-Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations, Biodiversity information management and communication.	15
3	<b>Conservation of Biodiversity:</b> Conservation of genetic diversity, species diversity and ecosystem diversity, <i>In situ</i> and <i>ex situ</i> conservation, Social approaches to conservation, Biodiversity awareness programmes, Sustainable development	10
4	<b>Role of plants in relation to Human Welfare;</b> a) Importance of forestry their utilization and commercial aspects b) Avenue trees, c) Ornamental plants of India. d) Alcoholic beverages through ages. Fruits and nuts: Important fruit crops their commercial importance. Wood and its uses. National and state institutes related to the activity.	10

Suggested readings

- Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity – Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi

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(vii) Ethnobotany







Credit: 3

Course outcomes

1. To learn the proper documentation and presentation of traditional knowledge about plants.
2. To use important plants by the tribal communities for various purposes.
3. To learn the conservation of wild growing plants and their socioeconomic impacts.

Unit	Topic	No. of lecturers/ hrs (45)
1	<b>Ethnobotany:</b> Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses	10
2	<b>Methodology of Ethnobotanical studies</b> a) Field work b) Herbarium c) Ancient Literature d) Temples and sacred places e) Indigenous knowledge system	10
3	<b>Role of ethnobotany in modern Medicine</b> Medico-ethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) <i>Azadiractha indica</i> b) <i>Ocimum sanctum</i> c) <i>Vitex negundo</i> . d) <i>Gloriosa superba</i> e) <i>Tribulus terrestris</i> f) <i>Pongamia pinnata</i> g) <i>Cassia auriculata</i> h) <i>Indigofera tinctoria</i> . Role of ethnobotany in modern medicine with special example <i>Rauwolfia septina</i> , <i>Trichopus zeylanicus</i> , <i>Artemisia</i> , <i>Withania</i> . Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).	15
4	<b>Ethnobotany and legal aspects</b> Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge. National and state institutes related to the activity.	10

  
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### Suggested readings

- Jain S.K. (1995). Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
- Jain S.K. (1981). Glimpses of Indian. Ethnobotany, Oxford and I B H, New Delhi.
- Jain S.K. (1989). Methods and approaches in ethnobotany. Society of Ethnobotanists, Lucknow, India.
- Jain S.K. (1990). Contributions of Indian ethnobotany. Scientific publishers, Jodhpur.
- Colton C.M. (1997). Ethnobotany-Principles and applications. John Wiley and sons Chichester.
- Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah.
- Rajiv K. Sinha (1996). Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur).

### (viii) Mushroom Cultivation

Credit: 3

#### Course outcome

1. Understand the economic importance of mushroom cultivation.
2. To learn the basic tools and techniques used in mushroom cultivation.
3. To learn the skills for developing commercial enterprise of mushroom cultivation.

Unit	Topic	No. of lecturers/ hrs (45)
1	Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India- <i>Volvariella volvacea</i> , <i>Pleurotus citrinopileatus</i> , <i>Agaricus bisporus</i> .	10
2	Cultivation methods: Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, Composting technology in mushroom production	15
3	Storage and nutrition: Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickels, papads), drying, storage in salt solutions. Nutrition- Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.	10
4	Food preparation: Delicacies of mushroom and its value addition, Research Centres - National level and Regional level. Cost benefit	10

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ratio - Marketing in India and abroad, Export Value. National and state institutes related to the activity.	
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**Suggested readings**

- Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R. (1991). Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
- Swaminathan, M. (1990). Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
- Tewari, P. and Kapoor, S.C. (1988). Mushroom cultivation, Mittal Publications, Delhi.
- Bahl, N. (2000). Hand book of Mushrooms. Oxford & Ibh Publishing Co. Pvt Ltd

**(ix) Intellectual Property Rights**

**Credit: 3**

1. Understand the basic concepts of intellectual property rights.
2. To learn the procedure for obtaining the intellectual property rights.

Unit	Topic	No. of lecturers/ hrs (45)
1	<b>Introduction to intellectual property right (IPR)</b> Concept and kinds. Economic importance. IPR in India and world: Genesis and scope, some important examples. IPR, WTO TRIPS and WIPO.	10
2	<b>Patents</b> Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, Working of patents, Infringement. <b>Copyrights</b> Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement. <b>Trademarks</b> Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defenses, Domain name. <b>Geographical Indications</b> Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position.	10
3	<b>Protection of Traditional Knowledge</b> Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio-Prospecting and Bio-Piracy, Alternative ways, Protectability, need for a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level,	10

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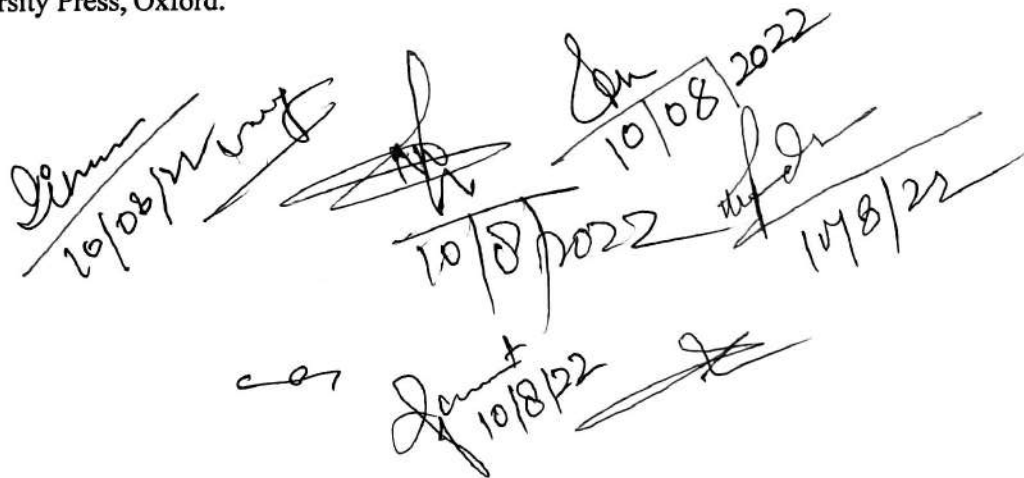
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	Traditional Knowledge Digital Library. <b>Industrial Designs</b> Objectives, Rights, Assignments, Infringements, Defences of Design Infringement	
4	<b>Protection of Plant Varieties</b> Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001. <b>Information Technology Related Intellectual Property Rights</b> Computer Software and Intellectual Property, Database and Data Protection, Protection of Semi-conductor chips, Domain Name Protection. <b>Biotechnology and Intellectual Property Rights.</b> Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions.	15

**Suggested readings**

- N.K. Acharya (2001). Textbook on intellectual property rights, Asia Law House.
- Manjula Guru and M.B. Rao (2003). Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications.
- P. Ganguli (2001). Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill.
- Miller, A.R. and Davis M.H. (2000). Intellectual Property: Patents, Trademarks and Copyright in Nutshell, West Group Publishers.
- Watal, J. (2003) Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford.


  
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**Sri Dev Suman Uttarakhand University,  
Badshahithaul, Tehri (Garhwal), Uttarakhand-249199**



## **NATIONAL EDUCATION POLICY-2020**

Common Minimum Syllabus for Sri Dev Suman  
Uttarakhand University Campus and all Affiliated Colleges  
for First Three Years of Higher Education

## **STRUCTURE OF UG - CHEMISTRY SYLLABUS**

**2022**



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2.	Prof. O.P.S. Negi Vice-Chancellor , Uttarakhand Open University	Member
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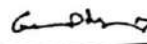


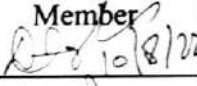
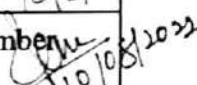
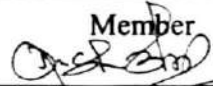
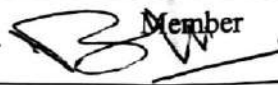
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Dr. Penny Joshi	Assistant Professor	D. S. B. Campus, Kumaun University, Nainital
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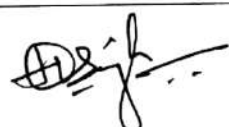

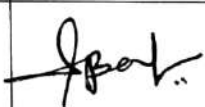
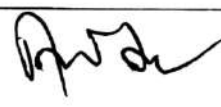
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Dr. G. C. Shah	Professor & Head	SSJ University, Almora
Dr. S. P. Sati	Professor	Sri Dev Suman Uttarakhand University, Pt. LMS Campus, Rishikesh

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2.	Prof. MS Rawat Pt. LMS Campus, Rishikesh, SDSU University. <span style="float: right;">Member</span>
3.	Prof. S. P. Sati HOD, Department of Chemistry, Pt. LMS Campus, Rishikesh, SDSU University. <span style="float: right;">Member </span>
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Dr. Rakesh Kumar Joshi Assistant Professor, Department of Chemistry, Pt. LMS Campus, Rishikesh, Sri Dev Suman Uttarakhand University.	Member	8279902189	

## Semester-wise Titles of the Papers in B.Sc. Chemistry

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
<b>Certificate in Introductory Chemistry</b>					
1	I		Fundamentals of Chemistry-I	Theory	4
			Chemical Analysis-I	Practical-1	2
	II		Fundamentals of Chemistry-II	Theory	4
			Chemical Analysis-II	Practical-1	2
<b>Diploma in Chemical Science</b>					
2	III		General Chemistry-I	Theory	4
			Analytical Procedures-I	Practical-2	2
	IV		General Chemistry-II	Theory	4
			Analytical Procedures-II	Practical-2	2
<b>Degree in Bachelor of Science</b>					
3	V		Inorganic Chemistry	Theory	4
			Organic Chemistry	Theory	4
			Analytical Procedures -III	Practical-3	2
			Research Project	Project	Qualifying
	VI		Physical Chemistry	Theory	4
			Analytical Chemistry	Theory	4
			Analytical Procedures -IV	Practical-3	2
			Research Project	Project	Qualifying

### Purpose of the Program

The Importance of chemistry arises because so many other disciplines draw on certain chemical principles and concepts. The purpose of the undergraduate chemistry program at the university and college level is to prepare our students for all those fields where basic knowledge of chemistry is required including academia for careers as professionals in various industries and research institutions.

### Program Outcomes

- PO 1.** Students will have a firm foundation in the fundamentals and applications of chemical and scientific theories including those in analytical, inorganic, organic and physical chemistry.
- PO 2.** Students will be able to design and carry out scientific experiments as well as accurately record and analyze the data of such experiments.
- PO 3.** Students will develop skill in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
- PO 4.** Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
- PO 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.
- PO 6.** Students will be able to explain why chemistry is an integral activity for addressing social, economic, and environmental problems.
- PO 7.** Students will be able to function as a member of an interdisciplinary problem-solving team.



<b>PROGRAM SPECIFIC OUTCOMES (PSOS)</b>	
<b>CERTIFICATE IN INTRODUCTORY CHEMISTRY</b>	
<b>First Year</b>	Certificate in Introductory Chemistry will give the student a basic knowledge of all the fundamental principles of chemistry like atomic structure, molecular polarity, bonding theories of different molecules, resonance concept, hyperconjugation, field effects, periodic properties of more than 111 elements, mechanism of organic reactions, stereochemistry, detailed study of states of matter including kinetic theories of gases, solid and liquid states, chemistry of aliphatic and aromatic compounds, chemical kinetics, its scope and first law of thermodynamics. Student will be able to understand the qualitative and quantitative chemical analysis of the compounds in the laboratory. This certificate course is definitely going to prepare the students for various fields of chemistry and will give an insight into all the branches of chemistry. It will enable students to join the diploma course (semester III and IV) in any University or College of Higher education in Uttarakhand
<b>Second Year</b>	<b>DIPLOMA IN CHEMICAL SCIENCE</b>
	Diploma in Chemical Science will provide the theoretical as well as practical knowledge of handling chemicals, apparatus, equipment and instruments. The knowledge about second law of thermodynamics, chemical equilibrium, phase equilibrium, electrochemistry, coordination chemistry, acid-base theories, chemistry of transition elements, halides, alcohols, phenols, aldehydes, ketones and carboxylic acids will enable the students to work as chemists in various industries. The experimental work during the diploma course will enhance the skill of the students regarding chemical and physical tests of inorganic as well as organic compounds along with some physical experiments which will be beneficial to achieve their goals in industrial sectors. It will enable students to join the Bachelor of Science course (semester V and VI) in any University or College of Higher education in Uttarakhand
<b>Third Year</b>	<b>DEGREE IN BACHELOR OF SCIENCE</b>
	Degree in Bachelor of Science programme aims to introduce very important aspects of modern-day course curriculum, namely, chemistry of nitrogen containing compounds, organometallic, lipids, fats, dyes, paints, reagents in organic synthesis, carbohydrates, proteins, biomolecules, data analysis, nano-chemistry, green chemistry, stability of coordination compounds, cement, paint, ceramics, glass, inorganic fertilizers, radioactivity, corrosion, magnetic behaviour of transition metal complexes, surface chemistry, quantum mechanics, solutions, third law of thermodynamics, photochemistry, and spectroscopic techniques. This knowledge will make the students skilled to work in various chemical industries like cement industries, agro product, paint industries, rubber industries, petrochemical industries, food processing industries, fertilizer industries, pollution monitoring and control agencies etc. It will also enable the students to understand the importance of the biomolecules in biological science and related fields. Upon completion of a degree, chemistry students will be able to employ critical thinking and scientific inquiry in the performance, design, interpretation and documentation of laboratory experiments. It will help a candidate to succeed at an entry-level position in chemical industry or a chemistry postgraduate program.

**Subject: Chemistry**

Year	Semester	Theory Paper	Units	Practical Paper	Units	Research Project	Total Credits of the Year subject
1	I	Fundamentals of Chemistry-I	<ol style="list-style-type: none"> <li>1. Atomic Structure and Periodic Properties</li> <li>2. Chemical Bonding-I</li> <li>3. Mechanism of Organic Reactions</li> <li>4. Stereochemistry of Organic Compounds</li> <li>5. States of Matter-I</li> <li>6. States of Matter-II</li> </ol>	Chemical Analysis-I	<ol style="list-style-type: none"> <li>1. Laboratory hazards and safety precautions</li> <li>2. Inorganic exercise (Acidic radicals including combinations and interfering radicals)</li> <li>3. Organic exercise</li> <li>4. Physical exercise</li> </ol>	NIL	4+2=6
	II	Fundamentals of Chemistry-II	<ol style="list-style-type: none"> <li>1. Chemical Bonding-II</li> <li>2. Salient Features of <i>s</i>- and <i>p</i>-Block Elements</li> <li>3. Aliphatic Compounds</li> <li>4. Aromatic Compounds</li> <li>5. Chemical Kinetics and Catalysis</li> <li>6. Thermodynamics I</li> </ol>	Chemical Analysis-II	<ol style="list-style-type: none"> <li>1. Laboratory hazards and safety precautions</li> <li>2. Inorganic exercise (acid-base titrations)</li> <li>3. Organic exercise</li> <li>4. Physical exercise</li> </ol>	NIL	4+2=6
2	III	General Chemistry-I	<ol style="list-style-type: none"> <li>1. Chemistry of Transition Elements (First, second and third Transition Series)</li> <li>2. Coordination Chemistry-I</li> <li>3. Halides</li> <li>4. Alcohols and Phenols</li> </ol>	Analytical Procedures-I	<ol style="list-style-type: none"> <li>1. Laboratory hazards and safety precautions</li> <li>2. Inorganic mixture analysis (including basic radicals)</li> <li>3. Organic exercise</li> <li>4. Physical exercise</li> </ol>	NIL	4+2=6

			5. Thermodynamics II 6. Chemical Equilibrium, Phase Equilibrium				
	IV	General Chemistry-II	1. Acids and Bases 2. Chemistry of Inner Transition Elements 3. Aldehydes and Ketones 4. Carboxylic Acids 5. Electrochemistry I 6. Electrochemistry II	Analytical Procedures-II	1. Laboratory hazards and safety precautions 2. Inorganic exercise (Redox titration) 3. Organic exercise 4. Physical exercise	NIL	4+2=6
3	V	Inorganic Chemistry	1. Metal-Ligand Bonding in Transition Metal Complexes 2. Thermodynamic and Kinetic Aspects of Coordination Compounds 3. Electronic Spectra of Transition Metal Complexes 4. Magnetic Properties of Transition Metal Complexes 5. Organometallic Chemistry 6. Some Industrially Important Inorganic Materials	Analytical Procedures -III	1. Laboratory hazards and safety precautions 2. Inorganic exercise (Synthesis) 3. Organic exercise 4. Physical exercise	Research Project (Qualifying)	4+4+2=10
		Organic Chemistry	1. Lipids and Fats 2. Reagents in Organic Synthesis				

			<ol style="list-style-type: none"> <li>3. Nitrogen containing organic Compounds</li> <li>4. Organometallic Compounds</li> <li>5. Dyes and Paints</li> <li>6. Carbohydrates and Proteins</li> </ol>				
VI	Physical Chemistry	<ol style="list-style-type: none"> <li>1. Surface Chemistry</li> <li>2. Elementary Quantum Mechanics</li> <li>3. Photochemistry</li> <li>4. Solutions and Colligative Properties</li> <li>5. Thermodynamics III</li> <li>6. Radiochemistry</li> </ol>	Analytical Procedures -IV	<ol style="list-style-type: none"> <li>1. Laboratory hazards and safety precautions</li> <li>2. Physical exercise</li> <li>3. Spectroscopic exercise/ Chromatographic technique</li> <li>4. Inorganic exercise (Gravimetric)</li> </ol>	Research Project (Qualifying)	4+4+2=10	
	Analytical Chemistry	<ol style="list-style-type: none"> <li>1. General Biochemistry</li> <li>2. Data Analysis</li> <li>3. Fundamentals of Nanochemistry</li> <li>4. Basics of Green Chemistry</li> <li>5. Analytical Techniques</li> <li>6. Spectroscopy</li> </ol>					

**Subject: Chemistry**

Course	Semester	Paper Title		Prerequisite for Paper	Elective for Major Subject	Hours per Semester	Total Credits of the Year subject
<b>Certificate in Introductory Chemistry</b>	I	Theory-1	Fundamentals of Chemistry-I	Chemistry of 12 <sup>th</sup> standard	Yes open for all	60	4
		Practical-1	Chemical Analysis-I	Chemistry of 12 <sup>th</sup> standard	Yes open for all	60	2
	II	Theory-1	Fundamentals of Chemistry-II	Passed Sem-I Theory paper-1	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	4
		Practical-1	Chemical Analysis-II	Opted Sem-II Theory Paper-1	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	2
<b>Diploma in Chemical Science</b>	III	Theory-1	General Chemistry-I	Passed Certificate Course in Introductory Chemistry	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	4
		Practical-2	Analytical Procedures-I	Opted Sem-III Theory Paper-1	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	2
	IV	Theory-1	General Chemistry-II	Passed Sem-III Theory Paper-1	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	4
		Practical-2	Analytical Procedures-II	Opted Sem-IV Theory Paper-1	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	2
<b>Degree in Bachelor of Science</b>	V	Theory-1	Inorganic Chemistry	Passed Sem-III and Sem-IV Theory papers	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	4
		Theory-2	Organic Chemistry	Passed Sem-III and Sem-IV Theory papers	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	4
		Practical-3	Analytical Procedures-III	Opted Sem-V Theory Paper-1 & 2.	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	2
		Research Project				60	Qualifying
	VI	Theory-1	Physical Chemistry	Passed Sem-V Theory papers	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	4
		Theory-2	Analytical Chemistry	Passed Sem-V Theory papers Theory papers	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	4
		Practical-3	Analytical Procedures-IV	Opted Sem-VI Theory Paper-1 & 2	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	2
		Research Project				60	Qualifying



### **Theory and Practical Examination Pattern**

Theory (External) and theory paper carrying **maximum marks 75** and shall consist of three sections A ,B and C. Examination duration shall be 02 hours.

- **Section A:** Multiple choice questions (MCQ)/ True and False/very very short answer type questions.  
Section A will consist 10 questions (each of one mark)- **10 Marks**
- **Section B:** Short Answer Type Questions (within 200 words)  
Section B will consist 08 questions, each of 07 marks in which 05 has to be answered- 35 Marks.
- **Section C:** (Long answer type, within 500 words)
- Section C will consist of 04 questions, each of 15 marks, in which 02 has to be answered- 30 marks

#### **A. Internal assessment**

*For each theory paper internal assessment shall be conducted periodically in the form of class tests and/or assignments/ group discussion/ oral presentation/ overall performance) during the semester period. Total marks allotted to internal assessment shall be 25. The evaluated answer sheets/assignments have to be retained by the Professor In-Charge for the period of six months and can be shown to the students if students want to see the evaluated answer sheets. The marks obtained by the students shall be submitted to the Head of concerned department/ the Principal of the College for uploading onto the University examination portal.*

#### **B. Practical**

*The laboratory work of the students has to be evaluated periodically. The internal assessment (in the form of lab test, lab record, internal evaluation, assignment/home assignment and attendance) of total 10 marks for each semester shall be conducted during the semester. In each semester practical examination(external) of 40 marks has to be conducted by two examiners (External and internal) having duration of 4 hours for I to IV Semester and 5 hours for V and VI Semester. The total number of students to be examined per batch should not be more than sixty. Marks obtained in the practical examination have to be submitted to the Head of the department/ Principal of the College. The Head of the Department/Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, SDSU University, Badshahithaul, Tehri (Garhwal).*

Year	Semester	Course Code	Paper Title	Theory/Practical	Credits
<b>Certificate in Introductory Chemistry</b>					
<b>1</b>	<b>I</b>		Fundamentals of Chemistry-I	Theory	4
			Chemical Analysis-I	Practical	2
<b>1</b>	<b>II</b>		Fundamentals of Chemistry-II	Theory	4
			Chemical Analysis-II	Practical	2

**Semester-I  
Paper-I (Theory)**

**Course Title: Fundamentals of Chemistry-I**

<b>Programme/Class:</b> Certificate in Introductory Chemistry	<b>Year:</b> First	<b>Semester:</b> First
Paper-I Theory Subject: Chemistry		
<b>Course Code:</b>	<b>Course Title:</b> Fundamentals of Chemistry-I	

**Course outcomes:** There is nothing more fundamental to chemistry than the chemical bond. Chemical bonding is the language of logic for chemists. Chemical bonding enables scientists to take the 100-plus elements of the periodic table and combine them in myriad ways to form chemical compounds and materials. Periodic trends, arising from the arrangement of the periodic table, provide chemists with an invaluable tool to quickly predict an element's properties. These trends exist because of the similar atomic structure of the elements within their respective group families or periods, and because of the periodic nature of the elements. Reaction mechanism gives the fundamental knowledge of carrying out an organic reaction in a step-by-step manner. This course will provide a broad foundation in chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective. Students will gain an understanding of;

- ✓ Molecular geometries, physical and chemical properties of the molecules.
- ✓ Current bonding models for simple inorganic and organic molecules in order to predict structures and important bonding parameters.
- ✓ This course gives a broader theoretical picture in multiple stages in an overall chemical reaction.
- ✓ It describes reactive intermediates, transition states and states of all the bonds broken and formed.
- ✓ It enables to understand the reactants, catalyst, stereochemistry and major and minor products of any organic reaction. It describes the types of reactions and the kinetic and thermodynamic aspects one should know for carrying out any reaction and the ways how the reaction mechanism can be determined.
- ✓ The chapter stereochemistry gives the clear picture of two-dimensional and three-dimensional structure of the molecules, and their role in reaction mechanism. The course will also strengthen the knowledge of students regarding complete picture of states of matter that includes gaseous, liquid, solid and colloidal states.

<b>Credits:4</b>	<b>Compulsory</b>
Max. Marks: 25+75	Min. Passing Marks: 33

Total Number of Hours = 60

Unit	Content	Number of Hours
1	<p><b>Atomic Structure and Periodic Properties:</b> Dual nature of matter; de Broglie concept. Heisenberg uncertainty principle; its significance. Atomic orbitals, Schrödinger wave equation (no derivation); significance of <math>\psi</math> and <math>\psi^2</math>. Quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p and d orbitals. Aufbau energy diagram, Pauli's exclusion principle. Hund's rule of maximum multiplicity. Electronic configuration of elements (s block, p block and first series of d-block elements). Effective nuclear charge, Slater's rule.</p> <p>The general idea of Modern periodic table, atomic and ionic radii, ionization potential, electron affinity, electronegativity-definition, trends of variation in periodic table and their application in prediction and explaining the chemical behaviour of elements and compounds thereof.</p>	12
2	<p><b>Chemical Bonding-I:</b> Ionic bond, covalent bond-Valence Bond Theory and its limitations; various types of hybridization and shapes of different inorganic and organic molecules. Valence Shell Electron Pair Repulsion Theory (VSEPR) and shapes of <math>\text{NH}_3</math>, <math>\text{H}_2\text{O}</math>, <math>\text{H}_3\text{O}^+</math>, <math>\text{SF}_4</math>, <math>\text{ClF}_3</math>, <math>\text{ICl}_2^-</math>, <math>\text{TeF}_5^-</math> <math>\text{NH}_4^+</math> and other simple molecules/ions (<math>\text{CO}_2</math>, <math>\text{SO}_2</math>, <math>\text{SO}_3</math>, <math>\text{Cl}_2\text{O}_7</math>, <math>\text{SO}_4^{2-}</math>, <math>\text{CO}_3^{2-}</math>, <math>\text{NO}_3^-</math>, <math>\text{PO}_4^{3-}</math>) including compounds of xenon.</p> <p>Resonance, hyperconjugation, field effects- inductive, mesomeric, electromeric effect</p>	8
3	<p><b>Mechanism of Organic Reactions:</b> Types of reagents-electrophiles and nucleophiles. Types of organic reactions. Energy considerations. Reactive intermediates- carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples).</p>	8
4	<p><b>Stereochemistry of Organic Compounds:</b> Types of isomerism-optical isomerism- elements of symmetry, molecular chirality, enantiomers, stereogenic centers, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centre, diastereomers, threo and erythro diastereomers, meso compounds, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D &amp; L and R &amp; S systems of nomenclature. Geometrical isomerism: determination of configuration of geometrical isomers, E &amp; Z system of</p>	12

	nomenclature.	
5	<p><b>States of Matter-I: Gaseous State</b>-Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waal's equation of states, Critical phenomena – PV isotherms of real gases, relationship between critical constants and van der Waals constants. Molecular velocities: Root mean square, average and most probable velocities, qualitative discussion of the Maxwell's distribution of molecular velocities, Numerical problems.</p> <p><b>Liquid State</b>-Intermolecular forces, Structural differences between solids, liquids and gases. Physical properties of liquids including their methods of determination: surface tension, viscosity, Numerical problems.</p>	12
6	<p><b>States of Matter-II:</b></p> <p><b>Solid State:</b> Introduction to crystalline materials, Definition of space lattice, unit cell, crystal planes, Miller indices, Laws of crystallography – (i) law of constancy of interfacial angles (ii) law of rationality of indices (iii) law of symmetry. Symmetry elements in crystals, X-ray diffraction by crystals. Bragg's equation, Numerical problems.</p> <p><b>Colloidal State:</b> Definition of colloids, classification of colloids. Solids in liquids (sols): properties – kinetic, optical and electrical; stability of colloids, protective action, Hardy-Schulze law, gold number.</p>	8

**Books Recommended:**

- i. Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5<sup>th</sup> edition.
- ii. Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33<sup>rd</sup> edition.
- iii. Madan, R.L., "Chemistry for Degree Students, B. Sc. First Year", S. Chand Publishing, New Delhi, India, 2011, 3<sup>rd</sup> edition.
- iv. Madan, R.D., Malik, U.M. and Tuli, G.D., "Selected topics in Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2010.
- v. Chandra, S., "Comprehensive Inorganic Chemistry" New Age International Publishers, India, 2018, 1<sup>st</sup> edition.
- vi. Prakash, S., Tuli, G.D., Basu, S.K. and Madan, R.D., "Advanced Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2000, Vol 1.
- vii. Finar, I.L., "Organic Chemistry", Pearson Education India, 2002, 6<sup>th</sup> edition.
- viii. Eliel, E.L. and Wilen, S.H., "Stereochemistry of Organic Compounds", Wiley, 1994, 1<sup>st</sup> edition.
- ix. Boyd, Morrison and Bhattacharjee, "Organic Chemistry", Pearson Education India, 2010, 7<sup>th</sup> edition.

- x. Mukerji, S.M., "Reaction mechanism in Organic Chemistry", Laxmi Publications, 2007, 3<sup>rd</sup> edition.
- xi. Singh, Jagdamba and Yadav, L.D.S., "Undergraduate Organic Chemistry" Pragati Prakashan, India, 2011, Vol 1.
- xii. Loudon, G. Marc, "Organic Chemistry", Oxford University Press, 2008, 4<sup>th</sup> edition.
- xiii. Atkins P.W., "Atkin's Physical Chemistry: International", Oxford University Press, 2018, 11<sup>th</sup> edition.
- xiv. Ball D.W., "Physical Chemistry", Cengage India Private Limited, 2017, 2<sup>nd</sup> edition.
- xv. Puri, B.R., Pathania, M.S. and Sharma, L.R., "Principles of Physical Chemistry", Vishal Publishing, India, 2020, 47<sup>th</sup> edition.
- xvi. Bahl, A., Bahl, B.S. and Tuli, G.D., "Essential of Physical Chemistry", S. Chand Publishing, India, 2010.
- xvii. Bariyar, A., Singh, R.P. and Dwivedi, A., "Text Book for B. Sc. Chemistry I", Anu Books, 2019.

**Suggested online links:**

1. <https://www.youtube.com/watch?v=ZeV3V0DjupQ&list=PLmxSS9XYst219YI3DjJUP52APmR9bea1Y>
2. [https://www.youtube.com/watch?v=q-P79gnqNR8&list=PLmUlqVgZsTVVRvO3R8g-x12EMc5vmcq\\_c](https://www.youtube.com/watch?v=q-P79gnqNR8&list=PLmUlqVgZsTVVRvO3R8g-x12EMc5vmcq_c)
3. <https://www.youtube.com/watch?v=gahQYHs0c8s>
4. [https://www.youtube.com/watch?v=w2He\\_Q0Mf0c](https://www.youtube.com/watch?v=w2He_Q0Mf0c)
5. <https://www.youtube.com/watch?v=q1qMFcZVIPk>
6. <https://www.youtube.com/watch?v=nWTgMr6idf0>
7. <https://www.youtube.com/watch?v=JNLJyhqXaTc&t=10s>
8. <https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm>
9. [https://onlinecourses.nptel.ac.in/noc22\\_cy36/preview](https://onlinecourses.nptel.ac.in/noc22_cy36/preview)
10. [https://onlinecourses.swayam2.ac.in/cec20\\_lb01/preview](https://onlinecourses.swayam2.ac.in/cec20_lb01/preview)

**Suggested Continuous Evaluation Methods:** 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.

Evaluation method	Marks
Home assignments/ group discussions/ oral presentations	10 marks
Mid-term evaluation (written test)	10 marks
Attendance	05 marks

**Course prerequisites:** To study this course, a student must have studied the chemistry of class 12<sup>th</sup> standard.



**Semester-I, Paper-II (Practical)**  
**Course Title: Chemical Analysis -I**

<b>Programme/Class:</b> Certificate in Introductory Chemistry	<b>Year:</b> First	<b>Semester:</b> First
Paper-2 Practical Subject: Chemistry		
<b>Course Code:</b>	<b>Course Title:</b> Chemical Analysis-I	

**Course outcomes:**

Upon completion of this course, the students will have the knowledge and skills to: understand the laboratory methods and tests related to inorganic mixture analysis and estimation of surface tension of commercial products. Also, they can understand the absolute configuration of organic molecules with the help of models. The students will be able to

- ✓ Qualitatively estimate anions and cations in samples.
- ✓ Determine the relative surface tension of a given liquid.
- ✓ Find out the absolute configuration of organic molecules.

<b>Credits:2</b>	<b>Compulsory</b>
Max. Marks: 10 + 40	Min. Passing Marks: 17

Total Number of Hours = 60

Unit	Contents	Number of Hours
1	Laboratory hazards and safety precautions	6
2	<b>Salt mixture analysis:</b> Identification of acid radicals (three to four) including anions in combination and basic radicals upto II Group in the given salt mixture.	18
3	<b>Organic exercise:</b> Determination of absolute configuration of organic molecules using ball and stick models. Students are supposed to sketch the structure of simple organic compounds showing their stereochemistry using Fischer Projection.	18
4	<b>Physical exercise:</b> Determination of relative surface tension of the given liquid using Stalagmometer.	18

**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in viva voce, record and overall performance.

Evaluation method	Marks
Practical s	05 marks
Viva voce/Record and overall performance/ Attendance	05 marks

**Course prerequisites:** To study this course, a student must have studied the chemistry of class 12<sup>th</sup> standard.

One exercise each from salt mixture analysis (acidic radicals), organic exercise (absolute configuration) and physical exercise (relative surface tension) shall be given in the examination.

**Distribution of marks shall be as given below:**

1. Inorganic salt analysis (Acidic and Basic radicals)	12
2. Organic exercise	10
3. Physical	08
4. Viva	05
5. Lab record	05
6. Home assignment/internal assessment, lab record and attendance	10
<b>TOTAL</b>	<b>50</b>

**Note:**

- *The lab work of the student has to be evaluated and assessed carefully and periodically. The semester lab record has to be maintained by the department/college as an official record.*
- *Less than zero mark will not be awarded.*
- *The total number of students to be examined per batch shall not be more than sixty.*
- *Duration of the practical examination shall be of 04 (four) hours.*
- *Marks obtained in the practical examination have to be submitted to the Head of the department/ Principal of the College. The Head of the Department/Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, SDSU University, Badshahithaul, Tehri(Garhwal).*

**Suggested Readings:**

- i. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
- ii. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
- iii. Harris, D. C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
- iv. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.
- v. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Edition.

**Suggestive digital platforms web links:**

1. <http://chemcollective.org/vlabs>
2. <https://www.vlab.co.in/broad-area-chemical-sciences>
3. <https://wp.labster.com/chemistry-virtual-labs/>

**Semester-II**  
**Paper-I (Theory)**  
**Course Title: Fundamentals of Chemistry-II**

<b>Programme/Class:</b> Certificate in Introductory Chemistry	<b>Year:</b> First	<b>Semester:</b> Second
Paper-I Theory Subject: Chemistry		
<b>Course Code:</b>	<b>Course Title:</b> Fundamentals of Chemistry-II	

**Course outcomes:** Upon successful completion of this course, the students will be able to describe the reactions shown by aliphatic and aromatic compounds. They will also be able to understand the bonding in inorganic molecules, salient features of s- and p- block elements, different aspects of chemical kinetics, catalysis and first law of thermodynamics.

<b>Credits: 4</b>	<b>Compulsory</b>	
Max. Marks: 25+75	Min. Passing Marks: 33	
Total Number of Hours = 60		
Units	Content	Number of Hours
1	<b>Chemical Bonding-II:</b> Molecular Orbital Theory (MOT) as applied to diatomic homonuclear/heteronuclear inorganic molecules. MO diagrams and bond order of H <sub>2</sub> , He <sub>2</sub> , Li <sub>2</sub> , Be <sub>2</sub> , B <sub>2</sub> , C <sub>2</sub> , N <sub>2</sub> , O <sub>2</sub> , F <sub>2</sub> , Ne <sub>2</sub> , CO, NO, HF difference between VB and MO theories. Multicentre bonding in electron deficient molecules. Polarization of covalent molecules, Percentage ionic character from dipole and electronegativity difference. Polarizing power and polarizability; Fajan's rule. Metallic bond- Electron Pool, valence bond and MO theories. Weak interactions-hydrogen bonding in inorganic and organic molecules and van der Waals interactions.	<b>10</b>
2	<b>Salient Features of s- and p-Block Elements:</b> General discussion with respect to all periodic (Occurrence, electronic configuration, atomic & ionic radii, density, ionization potential, metallic behaviour, electropositive nature, electronegativity, electron affinity, hydration energy, flame colouration, photoelectric effect, polarization power, boiling and melting point) and chemical properties (reactivity towards water, oxygen, air and moisture, hydrogen, halogens, ammonia). Diagonal relationship, catenation, inert pair effect, pπ- pπ, dπ-pπ bond, chemistry of hydrides, halides, oxides and oxyacids of p-block elements. Silicates, Boron nitrogen compounds (borazene and boron nitrides), interhalogen compounds, basic property of iodine.	<b>10</b>

3	<p><b>Aliphatic Compounds:</b> Chemical reactions of alkanes. Mechanism of free radical halogenation of alkanes. Cycloalkanes- Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring-bent or banana bonds.</p> <p>Chemical reactions of alkenes- mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's Rule, hydroboration-oxidation, oxymercuration-reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with <math>\text{KMnO}_4</math>, Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes. Industrial applications of ethylene and propene.</p> <p>Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, hydroboration-oxidation, metal- ammonia reduction, oxidation and polymerization.</p>	10
4	<p><b>Aromatic Compounds:</b> Aromaticity- the Hückel rule, aromatic ions. Aromatic electrophilic substitution- general pattern of the mechanism, role of <math>\sigma</math> and <math>\pi</math> complexes. Mechanism of nitration, halogenation, sulphonation, mercuration and Friedel- Crafts reaction. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives.</p>	10
5	<p><b>Chemical Kinetics and Catalysis:</b> Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction- concentration, temperature, pressure, solvent, light, catalyst; hetero and homocatalysis, significance. Inhibitors, poisons and promoters. Concentration dependence of rates of simple reaction, Molecularity, Order of reaction- zero order, first order, second order, pseudo-order, Radioactive decay a first order phenomenon, half-life period, Methods of determination of the order of reaction- differential method, method of integration, method of half-life period and isolation methods, Numerical problems.</p>	10
6	<p><b>Thermodynamics I:</b> Definition of thermodynamic terms, system, surroundings etc. Types of thermodynamic systems and thermodynamic processes. Intensive and extensive properties. Concept of heat and work, first law of thermodynamics, definition of internal energy and enthalpy. Heat capacity – heat capacities at constant volume and at constant pressure and their relationship, calculation of <math>w</math>, <math>q</math>, <math>dU</math> &amp; <math>dH</math> for the expansion of ideal gases under isothermal and reversible conditions. Thermochemistry; standard state, Standard enthalpy of formation – Hess's law of heat summation and its application. Temperature dependence of enthalpy, Kirchoff's equation, Numerical problems.</p>	10

**Books Recommended:**

- i. Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5<sup>th</sup> edition.
- ii. Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33<sup>rd</sup> edition.
- iii. Madan, R.L., "Chemistry for Degree Students, B. Sc. First Year", S. Chand Publishing, New Delhi, India, 2011, 3<sup>rd</sup> edition.
- iv. Madan, R.D., Malik, U.M. and Tuli, G.D., "Selected topics in Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2010.
- v. Chandra, S., "Comprehensive Inorganic Chemistry" New Age International Publishers, India, 2018, 1<sup>st</sup> edition.
- vi. Prakash, S., Tuli, G.D., Basu, S.K. and Madan, R.D., "Advanced Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2000, Vol 1.
- vii. Finar, I.L., "Organic Chemistry", Pearson Education India, 2002, 6<sup>th</sup> edition.
- viii. Eliel, E.L. and Wilen, S.H., "Stereochemistry of Organic Compounds", Wiley, 1994, 1<sup>st</sup> edition.
- ix. Boyd, Morrison and Bhattacharjee, "Organic Chemistry", Pearson Education India, 2010, 7<sup>th</sup> edition.
- x. Mukerji, S.M., "Reaction mechanism in Organic Chemistry", Laxmi Publications, 2007, 3<sup>rd</sup> edition.
- xi. Singh, Jagdamba and Yadav, L.D.S., "Undergraduate Organic Chemistry" Pragati Prakashan, India, 2011, Vol 1.
- xii. Loudon, G. Marc, "Organic Chemistry", Oxford University Press, 2008, 4<sup>th</sup> edition.
- xiii. Atkins P.W., "Atkin's Physical Chemistry: International", Oxford University Press, 2018, 11<sup>th</sup> edition.
- xiv. Ball D.W., "Physical Chemistry", Cengage India Private Limited, 2017, 2<sup>nd</sup> edition.
- xv. Puri, B.R., Pathania, M.S. and Sharma, L.R., "Principles of Physical Chemistry", Vishal Publishing, India, 2020, 47<sup>th</sup> edition.
- xvi. Bahl, A., Bahl, B.S. and Tuli, G.D., "Essential of Physical Chemistry", S. Chand Publishing, India, 2010.
- xvii. Bariyar, A., Singh, R.P. and Dwivedi, A., "Text Book for B. Sc. Chemistry I", Anu Books, 2019.

**Suggested online links:**

1. [https://www.youtube.com/watch?v=Gg4-go6tTiA&list=PLmxSS9XYst208kJs0npO\\_v\\_L-AGkHZJIS](https://www.youtube.com/watch?v=Gg4-go6tTiA&list=PLmxSS9XYst208kJs0npO_v_L-AGkHZJIS)
2. [https://www.youtube.com/watch?v=sz17\\_NnMPak&t=51s](https://www.youtube.com/watch?v=sz17_NnMPak&t=51s)
3. <https://www.youtube.com/channel/UCUxhnr9H2IYKsuRypG0MAfw/videos>
4. [https://onlinecourses.swayam2.ac.in/nce19\\_sc15/preview](https://onlinecourses.swayam2.ac.in/nce19_sc15/preview)
5. <https://www.openlearning.com/courses/introduction-to-physical-chemistry/?cl=1>
6. <https://www.careers360.com/university/indian-institute-of-technology-bombay/chemistry-of-main-group-elements-certification-course>
7. [https://onlinecourses.swayam2.ac.in/cec20\\_lb01/preview](https://onlinecourses.swayam2.ac.in/cec20_lb01/preview)
8. <https://nptel.ac.in/courses/104/103/104103071/>

**Suggested Continuous Evaluation Methods:** 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.

Evaluation method	Marks
Home assignments/ group discussions/ oral presentations	10 marks
Mid-term evaluation (written test)	10 marks
Attendance	05 marks

**Course prerequisites:** To study this course, a student must have passed Sem-I, Theory paper-1

**Semester-II, Paper-II (Practical)**  
**Course Title: Chemical Analysis -II**

<b>Programme/Class:</b> Certificate in Introductory Chemistry	<b>Year:</b> First	<b>Semester:</b> Second
Paper-2 Practical Subject: Chemistry		
Course Code:	Course Title: Chemical Analysis –II	

**Course outcomes:**

After completing this course, the students will be able to quantitatively find out the amount of acid or base in the samples, to qualitatively differentiate among different classes of organic compounds and to measure the relative viscosity of a given liquid.

<b>Credits:2</b>	<b>Compulsory</b>
Max. Marks: 10 + 40	Min. Passing Marks: 17

Total Number of Hours = 60

Unit	Contents	Number of Hours
<b>1</b>	Laboratory hazards and safety precautions	<b>6</b>
<b>2</b>	<b>Inorganic exercise:</b> Acid-base titrations; preparation of a solution in normal/molar terms, its standardization using a primary standard solution, determination of the strength of unknown solution. For example: preparation of NaOH solution (secondary standard say N/10), preparation of (COOH) <sub>2</sub> solution (primary standard say N/10), standardization of NaOH solution titrating it against (COOH) <sub>2</sub> solution using phenolphthalein (indicator) and then determination of the strength of given HCl solution.	<b>18</b>



<b>3</b>	<b>Organic exercise:</b> Differentiation between alkanes, alkenes and alkynes. Differentiation between aliphatic and aromatic compounds using chemical and physical tests.	<b>18</b>
<b>4</b>	<b>Physical exercise:</b> Determination of relative viscosity of the given liquid using Ostwald viscometer.	<b>18</b>

#### Suggested Readings:

- i. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
- ii. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
- iii. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
- iv. Harris, D. C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
- v. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.
- vi. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Edition.
- vii. Mikes, O. & Chalmes, R.A. Laboratory Handbook of Chromatographic & Allied Methods, Elles Harwood Ltd. London.
- viii. Ditts, R.V. Analytical Chemistry: Methods of separation. Van Nostrand, New York, 1974.

#### Suggestive digital platforms web links

1. <https://www.labster.com/chemistry-virtual-labs/>
2. <https://www.vlab.co.in/broad-area-chemical-sciences>
3. <http://chemcollective.org/vlabs>

**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in viva voce, record and overall performance.

Evaluation method	Marks
Practical s	05 marks
Viva voce/Record and overall performance/ Attendance	05 marks

**Course prerequisites:** To study this course, a student must have opted Semester-II Theory Paper-I

#### Suggested equivalent online courses

One exercise each from volumetric analysis (acid-base titration), organic exercise (tests for alkanes, alkenes, alkynes, aliphatic and aromatic compounds) and physical exercise (relative viscosity) shall be given in the examination.

#### Distribution of marks shall be as given below:

1. Inorganic salt analysis (Acidic and Basic radicals)	12
2. Organic exercise	10
3. Physical	08
4. Viva	05
5. Lab record	05
6. Home assignment/internal assessment, lab record and attendance	10
<b>TOTAL</b>	<b>50</b>

**Note:**

- *The lab work of the student has to be evaluated and assessed carefully and periodically. The semester record has to be maintained by the department/college as an official record.*
- *Less than zero mark will not be awarded.*
- *The total number of students to be examined per batch shall not be more than sixty.*
- *Duration of the practical examination shall be of 04 (four) hours.*
- *Marks obtained in the practical examination have to be submitted to the Head of the department/ Principal of the College. The Head of the Department/Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, SDSU University, Badshahi Thaul, Tehri (Garhwal).*

Year	Semester	Course Code	Paper Title	Theory/Practical	Credits
<b>Diploma in Chemical Science</b>					
2	III		General Chemistry-I	Theory	4
			Analytical Procedures-I	Practical	2
2	IV		General Chemistry-II	Theory	4
			Analytical Procedures-II	Practical	2

**Semester-III****Paper-I (Theory)****Course Title: General Chemistry-I**

<b>Programme/Class:</b> Diploma in Chemical Science	<b>Year:</b> Second	<b>Semester:</b> Third
Paper-I Theory Subject: Chemistry		
<b>Course Code:</b>	<b>Course Title:</b> General Chemistry-II	

**Course outcomes:** This paper provides detailed knowledge of synthesis of various classes 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.

- ✓ It relates and gives an analytical aptitude for synthesizing various industrially important compounds.
- ✓ This paper also provides a detailed knowledge on the elements present in our surroundings, their occurrence in nature. Their position in periodic table, their physical and chemical properties. This paper also gives detailed understanding of the d-block elements and their characteristics.

- ✓ After successful completion of this course, the students will be able to gather the information regarding Werner's theory and VBT of transition metal complexes.
- ✓ Students will be able to learn the basic concepts of spontaneity, chemical and phase equilibrium and able to apply these concepts in predicting the spontaneous reactions and will be able to solve the numerical problems based on these concepts.

<b>Credit: 4</b>	<b>Compulsory</b>
<b>Max. Marks: 25+75</b>	<b>Min. Passing Marks: 33</b>
Total No. of Hours- = 60	

Unit	Contents	Number of Hours
1	<p><b>Chemistry of Transition Elements (First, second and third Transition Series):</b> Characteristic properties of the elements; electronic configuration, atomic &amp; ionic radii, oxidation states and stability of uncommon oxidation states, ionization energy, boiling &amp; melting points, complex compound formation, colour, catalytic properties and magnetic properties. coordination number and geometry.</p> <p>Comparative treatment of 3d, 4d and 5d elements and their analogues in respect of occurrence, atomic &amp; ionic radii, oxidation state, ionization energy, complex formation tendency, magnetic behaviour, geometry and colour.</p>	10
2	<p><b>Coordination Chemistry-I:</b> Definition, terminology (ligand, coordination number, coordination sphere, complex ion etc.), Nomenclature of coordination compounds (IUPAC system), Werner's theory for coordination compounds; its experimental verification, effective atomic number (EAN) concept, 18-electron rule, stability of complexes and factors contributing to the stability. Chelates- Introduction, factors affecting the stability of chelates, thermodynamic origin of stability, applications. Valence Bond Theory (VBT) for coordination compounds, geometry of complexes (tetrahedral, octahedral, square planar), magnetic properties of complex compounds.</p>	10
3	<p><b>Halides:</b> Chemical reactions. Alkyl, aryl and vinyl halides. Mechanism of nucleophilic substitution reactions, S<sub>N</sub>2 and S<sub>N</sub>1 reactions with energy profile diagrams.</p>	8
4	<p><b>Alcohols and Phenols:</b> Alcohols: Reactions of alcohols. Dihydric alcohols-methods of preparation, chemical reactions of vicinal glycols, oxidative cleavage [Pb(OAc)<sub>4</sub> and HIO<sub>4</sub>] and pinacol-pinacolone rearrangement. Trihydric alcohols-methods of formation, chemical reactions of glycerol.</p>	12

	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. Mechanism of Fries rearrangement, Claisen condensation, Gatterman synthesis, Houben-Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction.	
5	<b>Thermodynamics II:</b> Second law of thermodynamics, need of 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 and T, entropy as a function of P and T, entropy change in physical and chemical processes, entropy change for reversible, irreversible and equilibrium condition. Clausius inequality, entropy as criteria of spontaneity and equilibrium. Entropy change in ideal gases. Gibbs free energy and Helmholtz work functions. Criteria for thermodynamic equilibrium and spontaneity, advantage Gibbs free energy and Helmholtz work functions over entropy change for spontaneity. Variation of G and A with P, V and T, Gibbs-Helmholtz equation, Numerical problems.	12
6	<b>Chemical Equilibrium:</b> The law of mass action, free energy and equilibrium constant, factors influencing equilibrium constant, relationship between $K_p$ and $K_c$ . Le-Chatelier's principle, Numerical problems.  <b>Phase Equilibrium:</b> Statement and meaning of the terms: phase, component and degree of freedom, Gibbs phase rule, phase equilibria of one component systems- water, carbon dioxide and sulphur. Raoult's and Henry's law.	8

**Books Recommended:**

- i. Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5<sup>th</sup> edition.
- ii. Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33<sup>rd</sup> edition.
- iii. Madan, R.L., "Chemistry for Degree Students, B. Sc. Second Year", S. Chand Publishing, New Delhi, India, 2011, 3<sup>rd</sup> edition.
- iv. Madan, R.D., Malik, U.M. and Tuli, G.D., "Selected topics in Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2010.
- v. Chandra, S., "Comprehensive Inorganic Chemistry" New Age International Publishers, India, 2018, 1<sup>st</sup> edition.
- vi. Prakash, S., Tuli, G.D., Basu, S.K. and Madan, R.D., "Advanced Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2000, Vol 1.
- vii. Finar, I.L., "Organic Chemistry", Pearson Education India, 2002, 6<sup>th</sup> edition.

- viii. Eliel, E.L. and Wilen, S.H., "Stereochemistry of Organic Compounds", Wiley, 1994, 1<sup>st</sup> edition.
- ix. Boyd, Morrison and Bhattacharjee, "Organic Chemistry", Pearson Education India, 2010, 7<sup>th</sup> edition.
- x. Mukerji, S.M., "Reaction mechanism in Organic Chemistry", Laxmi Publications, 2007, 3<sup>rd</sup> edition.
- xi. Singh, Jagdamba and Yadav, L.D.S., "Undergraduate Organic Chemistry" Pragati Prakashan, India, 2011, Vol 1.
- xii. Loudon, G. Marc, "Organic Chemistry", Oxford University Press, 2008, 4<sup>th</sup> edition.
- xiii. Atkins P.W., "Atkin's Physical Chemistry: International", Oxford University Press, 2018, 11<sup>th</sup> edition.
- xiv. Ball D.W., "Physical Chemistry", Cengage India Private Limited, 2017, 2<sup>nd</sup> edition.
- xv. Puri, B.R., Pathania, M.S. and Sharma, L.R., "Principles of Physical Chemistry", Vishal Publishing, India, 2020, 47<sup>th</sup> edition.
- xvi. Bahl, A., Bahl, B.S. and Tuli, G.D., "Essential of Physical Chemistry", S. Chand Publishing, India, 2010.

**Suggested online links:**

1. <https://www.youtube.com/watch?v=Fmclk9oUkEE&list=PLmxSS9XYst20Pz1SpRI4jdcrv-zh1AoYy>
2. <https://www.youtube.com/watch?v=y67STFWoQ3A&list=PLmUlqVgZsTVV9zQAF-umZzs65MzOU8Ty9>
3. [https://www.youtube.com/watch?v=xo2sRayaVyc&list=PLmUlqVgZsTVUAETHwJsJw\\_WPE87\\_yfhCO](https://www.youtube.com/watch?v=xo2sRayaVyc&list=PLmUlqVgZsTVUAETHwJsJw_WPE87_yfhCO)
4. <https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm>
5. <https://nptel.ac.in/courses/104/103/104103071/#>
6. <https://swayam.gov.in/>
7. <https://nptel.ac.in/courses/104/103/104103071/>

**Suggested Continuous Evaluation Methods:** 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.

Evaluation method	Marks
Home assignments/ group discussions/ oral presentations	10 marks
Mid-term evaluation (written test)	10 marks
Attendance	05 marks

**Course prerequisites:** To study this course, a student must have passed Certificate Course in Introductory Chemistry.

**Semester-III Paper-II (Practical)**  
**Course Title: Analytical Procedures-I**

<b>Programme/Class:</b> Diploma in Chemical Science	<b>Year:</b> Second	<b>Semester:</b> Third
Paper-II Practical Subject: Chemistry		
<b>Course Code:</b>	<b>Course Title:</b> Analytical Procedures-I	

**Course outcomes:**

After completing this course, the students will be able to test the inorganic mixtures of acidic and basic radicals in given samples, to qualitatively differentiate between alcohols and phenols and determine the critical solution temperature of partially miscible liquids.

<b>Credits:2</b>	<b>Compulsory</b>
Max. Marks: 10 + 40	Min. Passing Marks: 17

Total Number of Hours = 60

Unit	Contents	Number of Hours
<b>1</b>	Laboratory hazards and safety precautions	<b>6</b>
<b>2</b>	<b>Inorganic exercise:</b> Complete analysis of inorganic mixture including both acid and basic radicals with a special emphasis on the role of common ion effect and solubility product.	<b>30</b>
<b>3</b>	<b>Organic exercise:</b> Functional group tests for alcohols and phenols. Differentiation between alcohols and phenols using chemical and physical tests.	<b>12</b>
<b>4</b>	<b>Physical exercise:</b> Determination of critical solution temperature (CST) <b>Or</b> Determination of Transition temperature of given inorganic salt	<b>12</b>

**Suggested Readings:**

- i. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
- ii. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wordsworth Publishing Company, Belmont, California, USA, 1988.
- iii. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
- iv. Harris, D. C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
- v. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.
- vi. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Edition.
- vii. Mikes, O. & Chalmes, R.A. Laboratory Handbook of Chromatographic & Allied Methods, Elles Harwood Ltd. London.
- viii. Ditts, R.V. Analytical Chemistry: Methods of separation. Van Nostrand, New York, 1974.



### Suggestive digital platforms web links

1. <https://www.labster.com/chemistry-virtual-labs/>
2. <https://www.vlab.co.in/broad-area-chemical-sciences>
3. <http://chemcollective.org/vlabs>

**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in viva voce, record and overall performance.

Evaluation method	Marks
Practical s	05 marks
Viva voce/Record and overall performance/ Attendance	05 marks

**Course prerequisites:** To study this course, a student must have opted Sem-III Theory Paper-1

One exercise each from Inorganic mixture (qualitative), organic exercise (tests for alcohols and phenols) and physical exercise (critical solution temperature) shall be given in the examination.

#### Distribution of marks shall be as given below:

1. Inorganic salt analysis (Acidic and Basic radicals)	12
2. Organic exercise	10
3. Physical	08
4. Viva	05
5. Lab record	05
6. Home assignment/internal assessment, lab record and attendance	10
<b>TOTAL</b>	<b>50</b>

#### Note:

- *The lab work of the student has to be evaluated and assessed carefully and periodically. The semester record has to be maintained by the department/college as an official record.*
- *Less than zero mark will not be awarded.*
- *The total number of students to be examined per batch shall not be more than sixty.*
- *Duration of the practical examination shall be of 04 (four) hours.*
- *Marks obtained in the practical examination have to be submitted to the Head of the department/ Principal of the College. The Head of the Department/Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, SDSU University, Badshahi Thaul, Tehri (Garhwal).*

**Semester-IV**  
**Paper-I (Theory)**  
**Course Title: General Chemistry-II**

<b>Programme/Class:</b> Diploma in Chemical Science	<b>Year:</b> Second	<b>Semester:</b> Fourth
Paper-I Theory Subject: Chemistry		
<b>Course Code:</b>	<b>Course Title:</b> General Chemistry-II	

**Course outcomes:** This paper provides detailed knowledge of synthesis of aldehydes, ketones, carboxylic acids and functional groups inter conversion. The students will be able to describe the concepts of electrochemistry in detail and its applications. Also, they will be able to solve the numerical problems based on these concepts. Students will be able to define the acids and bases on the basis of various concepts/ theories and will be able to identify the position of various elements in the periodic table and able to explain their properties on the basis of their position.

<b>Credits: 4</b>	<b>Compulsory</b>
Max. Marks: 25+75	Min. Passing Marks: 33

Total No. of Hours- = 60

Unit	Contents	Number of Hours
1	<b>Acids and Bases:</b> Arrhenius concept, Bronsted-Lowry concept, Lux-Flood and Lewis concept of acids and bases; Hard and Soft Acid-Base Theory: Classification of acids and bases as hard and soft. Pearson's hard and soft acid base concept, acid base strength and hardness and softness. Symbiosis, theoretical basis of hardness and softness, electronegativity and hardness and softness; Role of the solvent and strength of acids and bases. Acid-base properties in non-aqueous media.	10
2	<b>Chemistry of Inner Transition Elements:</b> Chemistry of Lanthanides: Electronic configuration, oxidation states, atomic & ionic radii, lanthanide contraction and its consequences, complex formation, colour; Methods of separation of lanthanides- fractional crystallization, fractional precipitation, change in oxidation state, solvent extraction and ion exchange methods.  <b>Chemistry of Actinides:</b> General features of actinides-electronic configuration, atomic & ionic radii, ionization potential, oxidation states and complex formation.	10

3	<b>Aldehydes and Ketones:</b> Comparative account of properties of aliphatic and aromatic aldehydes and ketones. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensation. Condensation with ammonia and its derivatives; Wittig reaction, Mannich reaction. Use of acetals as protecting group. Oxidation of aldehydes, Baeyer-Villiger oxidation of ketones, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, $\text{LiAlH}_4$ and $\text{NaBH}_4$ reductions. Halogenation of enolizable ketones. An introduction to $\alpha$ -, $\beta$ -unsaturated aldehydes and ketones.	10
4	<b>Carboxylic Acids:</b> Reactions of carboxylic acids, Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids, mechanism of decarboxylation. Methods of formation and chemical reactions of halo acids, hydroxy acids- malic, tartaric, and citric acids. Methods of preparation and chemical reactions of unsaturated monocarboxylic acids. Dicarboxylic acids-methods of preparation and effect of heat and dehydrating agents.	10
5	<b>Electrochemistry I:</b> Electrical transport-conduction in metals and electrolytic solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution. Arrhenius theory of electrolytic dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law, its uses and limitations, Numerical Problems.	8
6	<b>Electrochemistry II:</b> Oxidation state, types of redox reactions, balancing of chemical reactions by ion electron and oxidation state method. Computations of equivalent weights. Types of reversible electrodes-gas-metal ion, metal-metal ion, metal-insoluble salt anion and redox electrodes. Electrode reactions, Nernst equation, derivation of cell EMF and single electrode potential, standard hydrogen electrode-reference electrode, standard electrode potential, sign conventions, electrochemical series and its significance. Electrolytic and Galvanic cells-reversible and irreversible cells, conventional representation of electrochemical cells. EMF of a cell and its measurements. Calculation of thermodynamic quantities of cell reactions ( $\Delta G$ , $\Delta H$ and $K$ ), Numerical Problems.	12

**Books Recommended:**

- i. Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5<sup>th</sup> edition.
- ii. Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33<sup>rd</sup> edition.
- iii. Madan, R.L., "Chemistry for Degree Students, B. Sc. Second Year", S. Chand

- Publishing, New Delhi, India, 2011, 3<sup>rd</sup> edition.
- iv. Madan, R.D., Malik, U.M. and Tuli, G.D., "Selected topics in Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2010.
  - v. Chandra, S., "Comprehensive Inorganic Chemistry" New Age International Publishers, India, 2018, 1<sup>st</sup> edition.
  - vi. Prakash, S., Tuli, G.D., Basu, S.K. and Madan, R.D., "Advanced Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2000, Vol 1.
  - vii. Finar, I.L., "Organic Chemistry", Pearson Education India, 2002, 6<sup>th</sup> edition.
  - viii. Eliel, E.L. and Wilen, S.H., "Stereochemistry of Organic Compounds", Wiley, 1994, 1<sup>st</sup> edition.
  - ix. Boyd, Morrison and Bhattacharjee, "Organic Chemistry", Pearson Education India, 2010, 7<sup>th</sup> edition.
  - x. Mukerji, S.M., "Reaction mechanism in Organic Chemistry", Laxmi Publications, 2007, 3<sup>rd</sup> edition.
  - xi. Singh, Jagdamba and Yadav, L.D.S., "Undergraduate Organic Chemistry" Pragati Prakashan, India, 2011, Vol 1.
  - xii. Loudon, G. Marc, "Organic Chemistry", Oxford University Press, 2008, 4<sup>th</sup> edition.
  - xiii. Atkins P.W., "Atkin's Physical Chemistry: International", Oxford University Press, 2018, 11<sup>th</sup> edition.
  - xiv. Ball D.W., "Physical Chemistry", Cengage India Private Limited, 2017, 2<sup>nd</sup> edition.
  - xv. Puri, B.R., Pathania, M.S. and Sharma, L.R., "Principles of Physical Chemistry", Vishal Publishing, India, 2020, 47<sup>th</sup> edition.
  - xvi. Bahl, A., Bahl, B.S. and Tuli, G.D., "Essential of Physical Chemistry", S. Chand Publishing, India, 2010.

**Suggested online links:**

1. <https://www.youtube.com/watch?v=UJgzQ5XP8wQ&list=PLmxSS9XYst20FfphDeS03pqkcuJk0vuvv>
2. <https://www.youtube.com/watch?v=2G79ICT5Os8&list=PLmxSS9XYst23WTFnTWuRg-Ww0k6foth7e>
3. <https://www.youtube.com/watch?v=SNXFYz31iFI&list=PLmUlqVgZsTVUfjMBLDQvNLUbF9CIReSef>
4. [https://www.youtube.com/watch?v=1t0GDMSzZ9A&list=PLmxSS9XYst21dec\\_6u2yWWj295Y8pHGrA](https://www.youtube.com/watch?v=1t0GDMSzZ9A&list=PLmxSS9XYst21dec_6u2yWWj295Y8pHGrA)
5. <https://swayam.gov.in/>
6. <https://www.coursera.org/learn/physical-chemistry>
7. <https://www.mooc-list.com/tags/physical-chemistry>
8. <https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm>
9. <https://nptel.ac.in/courses/104/103/104103071/>

**Suggested Continuous Evaluation Methods:** 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.

Evaluation method	Marks
Home assignments/ group discussions/ oral presentations	10 marks
Mid-term evaluation (written test)	10 marks
Attendance	05 marks

**Course prerequisites:** To study this course, a student must have had Passed Sem-III Theory Paper-1

**Semester-IV Paper-II (Practical)**  
**Course Title: Analytical Procedures-II**

<b>Programme/Class:</b> Diploma in Chemical Science	<b>Year:</b> Second	<b>Semester:</b> Fourth
Paper-II Practical Subject: Chemistry		
<b>Course Code:</b>	<b>Course Title:</b> Analytical Procedures-II	

**Course outcomes:**

After completing this course, the students will be able to determine the concentrations of oxidising and reducing agents through double titration, qualitatively differentiate between aldehydes, ketones and carboxylic acids and determine the solubility of salts.

<b>Credits:2</b>	<b>Compulsory</b>
Max. Marks: 10 + 40	Min. Passing Marks: 17

Total Number of Hours = 60

Unit	Contents	Number of Hours
<b>1</b>	Laboratory hazards and safety precautions	<b>6</b>
<b>2</b>	<b>Inorganic exercise:</b> Volumetric exercises (double titration) based on redox reactions involving internal as well as external indicators.	<b>18</b>
<b>3</b>	<b>Organic exercise:</b> Preliminary and Functional group tests for aldehydes, ketones and carboxylic acids (both aliphatic and aromatic).	<b>18</b>
<b>4</b>	<b>Physical exercise:</b> Determination of solubility of salts.	<b>18</b>

**Suggestive digital platforms web links**

1. <https://www.labster.com/chemistry-virtual-labs/>
2. <https://www.vlab.co.in/broad-area-chemical-sciences>
3. <http://chemcollective.org/vlabs>

**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of

score obtained in viva voce, record and overall performance.

Evaluation method	Marks
Practical s	05 marks
Viva voce/Record and overall performance/ Attendance	05 marks

**Course prerequisites:** To study this course, a student must have Opted Sem-IV Theory Paper-1

One exercise each from inorganic volumetric analysis (quantitative), organic exercise (tests for aldehydes, ketones and carboxylic acids) and physical exercise (solubility of salts) shall be given in the examination.

**Distribution of marks shall be as given below:**

1. Inorganic salt analysis (Acidic and Basic radicals)	12
2. Organic exercise	10
3. Physical	08
4. Viva	05
5. Lab record	05
6. Home assignment/internal assessment, lab record and attendance	10
<b>TOTAL</b>	<b>50</b>

**Note:**

- *The lab work of the student has to be evaluated and assessed carefully and periodically. The semester record has to be maintained by the department/college as an official record.*
- *Less than zero mark will not be awarded.*
- *The total number of students to be examined per batch shall not be more than sixty.*
- *Duration of the practical examination shall be of 04 (four) hours.*
- *Marks obtained in the practical examination have to be submitted to the Head of the department/ Principal of the College. The Head of the Department/Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, SDSU University, Badshahi Thaul, Tehri (Garhwal).*

Year	Semester	Course Code	Paper Title	Theory/Practical	Credits
<b>Degree in Bachelor of Science</b>					
<b>3</b>	<b>V</b>		Inorganic Chemistry	Theory	4
			Organic Chemistry	Theory	4
			Analytical Procedures-III	Practical	2
<b>3</b>	<b>VI</b>		Physical Chemistry	Theory	4
			Analytical Chemistry	Theory	4
			Analytical Procedures-IV	Practical	2



**Semester-V**  
**Paper-I (Theory)**  
**Course Title: Inorganic Chemistry**

<b>Programme/Class: Degree</b>	<b>Year: Third</b>	<b>Semester: Fifth</b>
<b>in Bachelor of Science</b>		
Paper-1 Theory Subject: Chemistry		
<b>Course Code:</b>	<b>Course Title: Inorganic Chemistry</b>	

**Course Outcomes:** Upon successful completion of this course, the students will be able to describe the stability, crystal field theory, electronic spectra and magnetic properties of coordination compounds. They will also learn about organometallic compounds, some industrially important inorganic materials and their applications in various industries. It will assist them to get a suitable job in the relevant industrial and scientific field.

<b>Credits:4</b>	<b>Compulsory</b>
Max. Marks: 25+75	Min. Passing Marks: 33

Total Number of Hours = 60

<b>Unit</b>	<b>Contents</b>	<b>Number of Hours</b>
1	<b>Metal-Ligand Bonding in Transition Metal Complexes:</b> Limitations of valence bond theory, an elementary idea about crystal field theory (CFT); crystal field splitting of octahedral and tetrahedral complexes, tetragonal distortion (Jahn-Teller distortion, crystal field splitting of square planar and trigonal bipyramidal complexes, factors affecting the crystal-field parameters, calculation of crystal field stabilization energy (CFSE), spectrochemical series. Applications (color and magnetic properties) and limitations CFT. Comparison between VBT and CFT.	10
2	<b>Thermodynamic and Kinetic Aspects of Coordination Compounds:</b> Stability of metal complexes- thermodynamic and kinetic stability, stable and unstable complexes, inert and labile complexes, stepwise and overall stability constants, relationship between the stepwise and overall stability constants, factors affecting the thermodynamic and kinetic stabilities of coordination compounds. Chelate effect and its thermodynamic origin. Determination of binary formation constants by pH-metry and spectrophotometry	10
3	<b>Electronic Spectra of Transition Metal Complexes:</b> Types of electronic transitions, selection rules for d-d transitions, calculations of spectroscopic ground states (Russell Saunders/L-S coupling), Orgel energy level diagram for $d^1$ , $d^4$ and $d^6$ , $d^9$ tetrahedral and octahedral complexes, discussion of the electronic spectrum of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ complex ion.	8

4	<b>Magnetic Properties of Transition Metal Complexes:</b> Origin of magnetic behavior, concept of magnetic susceptibility, diamagnetism, paramagnetism, ferromagnetism, ferrimagnetism and antiferromagnetism, magnetic moments, quenching of orbital magnetic moment by crystal field, magnetic susceptibility-definition relationship with temperature, Curie law and Curie Weiss law. methods of determining magnetic susceptibility; Gouy's and Quincke's methods, magnetic moment, spin only formula, correlation of $\mu_s$ and $\mu_{eff}$ values, orbital contribution to magnetic moments, application of magnetic moment data for 3d metal complexes.	10
5	<b>Organometallic Chemistry:</b> Definition, nomenclature and classification based on nature of metal-carbon bond. EAN and 18-electron rule. Definition, nomenclature, classification, general methods of preparation of organometallic compounds and a brief account of metal-ethylenic complexes. Applications of organometallic compounds-Ziegler-Natta catalyst, Wilkinson catalyst (No mechanism).	8
6	<b>Some Industrially Important Inorganic Materials:</b> Silicones, siloxanes, polymethylhydrosiloxanes, their applications. Phosphazenes, nature of bonding in triphosphazenes. Aluminosilicates- Feldspars, Ultramarines, Zeolites. Clays and Pillared Clays.  Cement- manufacture, composition and setting. Glass-manufacture, annealing, types and uses. Ceramics-definition, traditional and new ceramics, structure of ceramics. Inorganic fertilizers-essential nutrients for plants, nitrogenous, phosphatic and potash fertilizers.	14

**Books Recommended:**

- i. Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5<sup>th</sup> edition.
- ii. Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33<sup>rd</sup> edition.
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- v. Prakash, S., Tuli, G.D., Basu, S.K. and Madan, R.D., "Advanced Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2000, Vol 1.
- vi. Madan, R.L., "Chemistry for Degree Students, B. Sc. Third Year", S. Chand Publishing, New Delhi, India, 2011, 3<sup>rd</sup> edition.

**Suggested online links:**

1. <https://www.youtube.com/watch?v=0BQ38GEYF7s&list=PLmxSS9XYst22OYcJbKWq66APcEq5pVsL1>
2. <https://www.youtube.com/watch?v=9oQcm281TT0&list=PLmxSS9XYst20MhuKSMREzLhG4ZBIdNys9>
3. <https://www.youtube.com/watch?v=WGd4gOncw9s&list=PLmxSS9XYst22CtJwFrXWVA9kCp7OP0kn>
4. <https://www.youtube.com/watch?v=R4rPlpWT1cA&list=PLmxSS9XYst21uxf3tsohnDUmTRFrvfVv8>
5. <https://www.youtube.com/watch?v=3TWLAJuVN0c&list=PLmxSS9XYst23hk5m9-MsHTpbADe1Mx-p8>
6. <https://www.youtube.com/watch?v=0k4ryWpwhmo&list=PLmxSS9XYst22xP0d02UtcIigt0GIofvVm>
7. <https://www.youtube.com/watch?v=0ZBMRjyHWfY&list=PLmxSS9XYst205pTMkWPmDa31v0s6DFoXM>
8. [https://www.youtube.com/watch?v=najS\\_fXL38U&list=PLmxSS9XYst23yE3f2Kqsir4lQ1dTmofFv&index=6](https://www.youtube.com/watch?v=najS_fXL38U&list=PLmxSS9XYst23yE3f2Kqsir4lQ1dTmofFv&index=6)
9. <https://www.youtube.com/watch?v=3VoKRgPj7OI&list=PLmxSS9XYst23yE3f2Kqsir4lQ1dTmofFv&index=8>
10. <https://www.youtube.com/watch?v=57hQHf1E3PE&list=PLmxSS9XYst23yE3f2Kqsir4lQ1dTmofFv&index=7>
11. <https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-cy19/>
12. [https://onlinecourses.nptel.ac.in/noc22\\_cy02/preview](https://onlinecourses.nptel.ac.in/noc22_cy02/preview)
13. <https://nptel.ac.in/courses/104/105/104105033/>
14. <https://nptel.ac.in/courses/104/101/104101079/>
15. [https://onlinecourses.nptel.ac.in/noc21\\_cy12/preview](https://onlinecourses.nptel.ac.in/noc21_cy12/preview)
16. <https://nptel.ac.in/courses/104/108/104108062/>
17. [https://onlinecourses.nptel.ac.in/noc21\\_cy36/preview](https://onlinecourses.nptel.ac.in/noc21_cy36/preview)
18. [https://onlinecourses.nptel.ac.in/noc22\\_cy05/preview](https://onlinecourses.nptel.ac.in/noc22_cy05/preview)
19. <https://nptel.ac.in/courses/104/105/104105033/>
20. <https://www.york.ac.uk/media/chemistry/research/douthwaite/Metal-Ligand%20bonding%20and%20Inorganic%20reaction%20mechanisms.pdf>
21. <https://nptel.ac.in/courses/104/106/104106089/>
22. [http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp\\_content/S000005CH/P000658/M014009/ET/1456899566CHE\\_P3\\_M5\\_etext.pdf](http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000658/M014009/ET/1456899566CHE_P3_M5_etext.pdf)
23. [http://ddugu.ac.in/epathshala\\_content1.aspx](http://ddugu.ac.in/epathshala_content1.aspx)
24. <https://www.uou.ac.in/sites/default/files/slm/BSCCH-301.pdf>
25. [http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp\\_content/chemistry/07.inorganic\\_chemistry-ii/31.magnetic\\_properties\\_of\\_transition\\_metal\\_ions/et/6388\\_et\\_chemistry\\_p7\\_m31\\_etext.pdf](http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/07.inorganic_chemistry-ii/31.magnetic_properties_of_transition_metal_ions/et/6388_et_chemistry_p7_m31_etext.pdf)
26. <https://egyankosh.ac.in/bitstream/123456789/15794/1/Unit-7.pdf>
27. <https://www.hhrc.ac.in/ePortal/Chemistry/IImsscchem-18pche3-unit1-sv.pdf>
28. <http://www.du.edu.eg/upFilesCenter/sci/1596861612.pdf>
29. <https://www.uou.ac.in/sites/default/files/slm/BSCCH-301.pdf>
30. <https://nptel.ac.in/courses/104/105/104105103/>
31. <https://www.uou.ac.in/sites/default/files/slm/BSCCH-301.pdf>
32. <https://nptel.ac.in/content/storage2/courses/103107086/module1/lecture1/lecture1.pdf>
33. <https://nptel.ac.in/content/storage2/courses/103107086/module4/lecture1/lecture1.pdf>

**Suggested Continuous Evaluation Methods:** 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.

Evaluation method	Marks
Home assignments/ group discussions/ oral presentations	10 marks
Mid-term evaluation (written test)	10 marks
Attendance	05 marks

**Course prerequisites:** To study this course, a student must have passed Sem-III and Sem-IV Theory papers.

**Suggested equivalent online courses:**

1. <https://www.labster.com/chemistry-virtual-labs/>
2. <https://www.vlab.co.in/broad-area-chemical-sciences>
3. <http://chemcollective.org/vlabs>

**Semester-V**  
**Paper-II (Theory)**  
**Course Title: Organic Chemistry**

<b>Programme/Class: Degree in Bachelor of Science</b>	<b>Year: Third</b>	<b>Semester: Fifth</b>
Paper-II Theory Subject: Chemistry		
<b>Course Code:</b>	<b>Course Title: Organic Chemistry</b>	

**Course Outcomes:** Upon successful completion of this course, the students should be able to describe the chemistry of nitrogen containing compounds, the basic understanding of the chemistry of industrially important materials such as lipids, fats, soaps, detergents, dyes, paints and reagents in organic synthesis. Upon completion of this course students may get job opportunities in food, soap, detergent, paint and other organic material based synthetic labs and industries. Biomolecules are important for the functioning of living organisms. These molecules perform or trigger important biochemical reactions in living organisms. When studying biomolecules, one can understand the physiological function that regulates the proper growth and development of a human body. This course aims to introduce the students with basic experimental understanding of carbohydrates and proteins.

<b>Credits:4</b>	<b>Compulsory</b>
Max. Marks: 25+75	Min. Passing Marks: 33

Total Number of Hours = 60

Unit	Contents	Number of Hours
1	<b>Lipids and Fats:</b> Lipids-Definition, categories, biological functions, metabolism, nutrition and health, tests, examples. Fats-Definition, biological importance, metabolism, digestion and it's metabolism. Soaps, Detergents and their action mechanism.	12
2	<b>Reagents in Organic Synthesis:</b> Reagent compounds, types of reagents, acetylene, ammonia, Bayer's reagent, NBS, n-butyl lithium, CAN, chromic acid, chromium trioxide, diborane, DMSO, dioxane, Fehling reagent, Grignard reagent, hydrazide, hydrogen peroxide, LAH, OsO <sub>4</sub> , PCl <sub>5</sub> , potassium dichromate, potassium permanganate, Raney Ni, silver nitrate, sodium borohydride, NaH, THF, TMS, SOCl <sub>2</sub> , Tollen's reagent.	12
3	<b>Nitrogen Containing Organic Compounds:</b> Chemical reactions of nitroalkanes. Mechanism of nucleophilic substitution in nitroarenes and their reduction in acidic, neutral and alkaline medium. Picric acid.  Halo nitroarenes-reactivity, structure and nomenclature of amines. Physical properties. Separation of mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amines. Amine salts as phase-transfer catalysts. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles), reductive amination of aldehydic and ketonic compounds. Gabriel-phthalimide reaction, Hofmann bromamide reaction. Reaction of amines, electrophilic aromatic substitution in aryl amines, reaction of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling.	14
4	<b>Organometallic Compounds:</b> Organ magnesium compounds; the Grignard reagent-formation, structure and chemical reactions. Organozinc compounds; formation and chemical reactions.	10
5	<b>Dyes and Paints:</b> Color and constitution, types of dyes, Alizarin, Indigo, Congo red, Malachite green, Methylene blue, Phenolphthalein, Methyl orange. Paints and Varnishes: Definition, components, chemistry, applications.	10

6	<p><b>Carbohydrates and Proteins:</b> Carbohydrates: Classification and nomenclature. Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threo diastereomers. Conversion of glucose into mannose. Formation of glycosides, ethers and esters. Cyclic structure of D(+)-glucose. Mechanism of mutarotation. General study of disaccharides.</p> <p><b>Proteins:</b> Classification, structure and stereochemistry of amino acids. Acid-base behavior, isoelectric point and electrophoresis. Classification of proteins.</p>	12
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#### Books Recommended:

- i. Finar, I.L., "Organic Chemistry", Pearson Education India, 2002, 6<sup>th</sup> edition.
- ii. Eliel, E.L. and Wilen, S.H., "Stereochemistry of Organic Compounds", Wiley, 1994, 1<sup>st</sup> edition.
- iii. Boyd, Morrison and Bhattacharjee, "Organic Chemistry", Pearson Education India, 2010, 7<sup>th</sup> edition.
- iv. Mukerji, S.M., "Reaction mechanism in Organic Chemistry", Laxmi Publications, 2007, 3<sup>rd</sup> edition.
- v. Singh, Jagdamba and Yadav, L.D.S., "Undergraduate Organic Chemistry" Pragati Prakashan, India, 2011, Vol 1.
- vi. Loudon, G. Marc, "Organic Chemistry", Oxford University Press, 2008, 4<sup>th</sup> edition.
- vii. Madan, R.L., "Chemistry for Degree Students, B. Sc. Third Year", S. Chand Publishing, New Delhi, India, 2011, 3<sup>rd</sup> edition.
- viii. Bahl, A. and Bahl, B.S. a "Advance Organic Chemistry", S. Chand Publishing, India, 2010.

#### Suggested online links:

1. [https://www.youtube.com/watch?v=xBNv80Dg6nI&list=PLmUlqVgZsTVUk5NkroUmYXvbterBXbk\\_J](https://www.youtube.com/watch?v=xBNv80Dg6nI&list=PLmUlqVgZsTVUk5NkroUmYXvbterBXbk_J)
2. [https://www.youtube.com/watch?v=UgbaIFI\\_q6E](https://www.youtube.com/watch?v=UgbaIFI_q6E)
3. <https://www.youtube.com/watch?v=tz0BrCqPTV0&t=15s>
4. <https://www.youtube.com/watch?v=2sHILNzTpUU&t=4s>
5. <https://www.youtube.com/watch?v=ALaTCbetFSg&t=210s>
6. <https://www.youtube.com/watch?v=kruIzuor5v8>
7. <https://www.youtube.com/watch?v=IuERNLx-J7k&t=19s>
8. <https://www.youtube.com/watch?v=RW7K1YbpNxx&t=1414s>
9. <https://www.youtube.com/watch?v=LcUoeFe0iN8>
10. <https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm>
11. <https://nptel.ac.in/courses/104/103/104103111/>
12. <https://nptel.ac.in/courses/104/103/104103071/>
13. [https://onlinecourses.nptel.ac.in/noc19\\_cy24/preview](https://onlinecourses.nptel.ac.in/noc19_cy24/preview)
14. <https://nptel.ac.in/content/storage2/courses/104103071/pdf/mod10.pdf>



**Suggested Continuous Evaluation Methods:** 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.

Evaluation method	Marks
Home assignments/ group discussions/ oral presentations	10 marks
Mid-term evaluation (written test)	10 marks
Attendance	05 marks

**Course prerequisites:** To study this course, a student must have passed Sem-III and Sem-IV Theory papers.

### Semester-V, Paper-III (Practical)

Course Title: Analytical Procedures-III

<b>Programme/Class:</b> Certificate in Introductory/General Chemistry	<b>Year:</b> Third	<b>Semester:</b> Fifth
Paper-III Practical Subject: Chemistry		
<b>Course Code:</b>	<b>Course Title:</b> Analytical Procedures-III	

#### Course outcomes:

Upon completion of this course, the students will have the knowledge and skills to understand the synthetic methods related to inorganic and organic fields. Also, they can easily analyze the nitrogen containing compounds and separate the binary organic mixture.

<b>Credits:2</b>	<b>Compulsory</b>
Max. Marks: 10+40	Min. Passing Marks: 17

Total Number of Hours = 60

Unit	Contents	Number of Hours
1	Laboratory hazards and safety precautions	6
2	<b>Inorganic exercise:</b> Inorganic synthesis – cuprous chloride, potash alum, chrome alum, ferrous oxalate, ferrous ammonium sulphate, tetraamminecopper(II) sulphate and hexaamminenickel(II) chloride. Crystallization of compounds.	14

<b>3</b>	<p><b>Organic exercise:</b>  <b>Organic qualitative analysis:</b> Analysis of Nitrogen containing organic compounds (detection of elements, amines, nitro, amides and anilides)  Binary mixture of organic compounds separable by water</p> <p><b>Organic synthesis:</b> through nitration, halogenation, acetylation, sulphonation and simple oxidation</p>	<b>40</b>
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**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in viva voce, record and overall performance.

Evaluation method	Marks
Attendance	05 marks
Viva voce/Record and overall performance	05 marks

**Course prerequisites:** To study this course, a student must have opted Sem-V Theory Paper-1 &2

**Suggested equivalent online courses:**

1. <https://www.labster.com/chemistry-virtual-labs/>
2. <https://www.vlab.co.in/broad-area-chemical-sciences>
3. <http://chemcollective.org/vlabs>

One exercise each from inorganic synthesis, organic qualitative analysis and organic synthesis shall be given in the examination.

**Distribution of marks shall be as given below:**

1. Inorganic salt analysis (Acidic and Basic radicals)	10
2. Organic exercise	20
3. Viva	05
4. Lab record	05
5. Home assignment/internal assessment, lab record and attendance	10
<b>TOTAL</b>	<b>50</b>

**Note:**

- *The lab work of the student has to be evaluated and assessed carefully and periodically. The semester record has to be maintained by the department/college as an official record.*
- *Less than zero mark will not be awarded.*
- *The total number of students to be examined per batch shall not be more than sixty.*
- *Duration of the practical examination shall be of 05(five) hours.*

- *Marks obtained in the practical examination have to be submitted to the Head of the department/ Principal of the College. The Head of the Department/Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, SDSU University, Badshahi Thaul, Tehri (Garhwal).*

**Semester-VI**  
**Paper-I (Theory)**  
**Course Title: Physical Chemistry**

<b>Programme/Class: Degree in Bachelor of Science</b>	<b>Year: Third</b>	<b>Semester: Sixth</b>
Paper-I Theory Subject: Chemistry		
<b>Course Code:</b>	<b>Course Title: Physical Chemistry</b>	

**Course outcomes:** The core concepts of Physical Chemistry have been included in this semester with a view that students' command over these topics will help them to understand the higher chemistry in PG classes. Their understanding of Photochemistry and Solutions will help him to explain the day today phenomenon of the relevant field whereas. Thermodynamics will help them to understand the natural flow of energy. Learning the Quantum Mechanics will help them to praise the beauty of behavior of fundamental particles. It will assist them to get a suitable job in the relevant industrial and scientific field.

<b>Credits:4</b>	<b>Compulsory</b>
Max. Marks: 25+75	Min. Passing Marks: 33

Total Number of Hours = 60

Unit	Contents	Number of Hours
1	<b>Surface Chemistry:</b> Definition of surface phenomenon-Adsorption. Chemical and physical adsorption, Factors affecting adsorption. Isotherm and Isobar. Free energy of adsorption. Quantitative treatment of adsorption, Freundlich's and Langmuir's adsorption model and their applications. Limitation of Langmuir adsorption model. Adsorption in catalysis, characteristics of catalyzed reactions.	10
2	<b>Elementary Quantum Mechanics:</b> Black-body radiation, Plank's radiation law, photoelectric effect, Bohr's model of hydrogen atom (no derivation) and its defects. Compton effect, de Broglie hypothesis, Heisenberg's uncertainty principle, operator concept, Hamiltonian operator, Schrödinger wave equation and its importance, physical interpretation of the wave function, Numerical Problems.	12
3	<b>Photochemistry:</b> Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry; Grothuss-Draper law, Lambert's law, Lambert-Beer's law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, Numerical Problems.	10

4	<b>Solutions and Colligative Properties:</b> Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solutions, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular mass determination. Osmosis, law of osmotic pressure, determination of molecular mass from osmotic pressure. Elevation of boiling point and depression in freezing point, Numerical Problems.	10
5	<b>Thermodynamics III:</b> Statement and concept of residual entropy, third law of thermodynamics, unattainability of absolute zero, Nernst heat theorem. Evaluation of absolute entropy from heat capacity data, Numerical Problems	8
6	<b>Radioactivity:</b> Definition, nature of radioactivity, emission, types of radioactivity, occurrence, Energetics and kinetics radioactivity, rates of radioactive transitions, Applications of radioactivity, Numerical Problems.	10

#### Books Recommended:

- i. Madan, R.L., "Chemistry for Degree Students, B. Sc. Third Year", S. Chand Publishing, New Delhi, India, 2011, 3<sup>rd</sup> edition.
- ii. Atkins P.W., "Atkin's Physical Chemistry: International", Oxford University Press, 2018, 11<sup>th</sup> edition.
- iii. Ball D.W., "Physical Chemistry", Cengage India Private Limited, 2017, 2<sup>nd</sup> edition.
- iv. Puri, B.R., Pathania, M.S. and Sharma, L.R., "Principles of Physical Chemistry", Vishal Publishing, India, 2020, 47<sup>th</sup> edition.
- v. Bahl, A., Bahl, B.S. and Tuli, G.D., "Essential of Physical Chemistry", S. Chand Publishing, India, 2010.
- vi. Atkins, P. and de Paula, J. (2005). Physical Chemistry: 7<sup>th</sup> edition. Oxford University Press.
- vii. Moore, W.J. (1976). Physical Chemistry: 5<sup>th</sup> edition. Orient Longman Limited.
- viii. Fundamentals of Photochemistry, K.K. Rohtagi-Mukherji, Wiley-Eastern.
- viii. Essentials of Molecular Photochemistry, A. Gilbert and J. Baggott, Blackwell Scientific Publication.
- ix. Introduction to Quantum Chemistry, A. K. Chandra, Tata McGraw Hill

#### Suggested online links:

1. <https://www.youtube.com/watch?v=CMYg3ElZwDY>
2. [https://www.youtube.com/watch?v=01dY\\_ILWdMA&t=4s](https://www.youtube.com/watch?v=01dY_ILWdMA&t=4s)
3. [https://onlinecourses.nptel.ac.in/noc20\\_cy27/preview](https://onlinecourses.nptel.ac.in/noc20_cy27/preview)
4. [https://onlinecourses.nptel.ac.in/noc21\\_cy20/preview](https://onlinecourses.nptel.ac.in/noc21_cy20/preview)
5. <https://www.classcentral.com/course/swayam-chemistry-i-introduction-to-quantum-chemistry-and-molecular-spectroscopy-3981>
6. <https://www.classcentral.com/course/swayam-quantum-chemistry-of-atoms-and-molecules-19982>

7. <https://nptel.ac.in/courses/104/108/104108057/>
8. <https://nptel.ac.in/courses/115/101/115101107/>
9. <https://nptel.ac.in/courses/104/101/104101124/>
10. <https://nptel.ac.in/courses/104/105/104105128/>
11. <https://www.classcentral.com/course/swayam-concepts-of-thermodynamics-13015>
12. [https://onlinecourses.nptel.ac.in/noc20\\_me20/preview](https://onlinecourses.nptel.ac.in/noc20_me20/preview)
13. <https://www.careers360.com/university/indian-institute-of-technology-kharagpur/concepts-of-thermodynamics-certification-course>
14. <https://www.coursera.org/learn/thermodynamics-intro>
15. [https://onlinecourses.nptel.ac.in/noc22\\_cy14/preview](https://onlinecourses.nptel.ac.in/noc22_cy14/preview)
16. [https://onlinecourses.nptel.ac.in/noc20\\_cy22/preview](https://onlinecourses.nptel.ac.in/noc20_cy22/preview)
17. [https://onlinecourses.nptel.ac.in/noc21\\_cy45/preview](https://onlinecourses.nptel.ac.in/noc21_cy45/preview)
18. [https://onlinecourses.nptel.ac.in/noc21\\_ch48/preview](https://onlinecourses.nptel.ac.in/noc21_ch48/preview)

**Suggested Continuous Evaluation Methods:** 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.

Evaluation method	Marks
Home assignments/ group discussions/ oral presentations	10 marks
Mid-term evaluation (written test)	10 marks
Attendance	05 marks

**Course prerequisites:** To study this course, a student must have passed Sem-V Theory papers.

**Semester-VI**  
**Paper-II (Theory)**  
**Course Title: Analytical Chemistry**

<b>Programme/Class: Degree in Bachelor of Science</b>	<b>Year: Third</b>	<b>Semester: Sixth</b>
Paper-II Theory Subject: Chemistry		
<b>Course Code:</b>	<b>Course Title: Analytical Chemistry</b>	

**Course outcomes:** After completion of this course, the students will be able to understand the chemistry of biomolecules. They will become acquainted in the field of data analysis. The new frontiers of chemistry such as nano-chemistry and green chemistry are the part of syllabi of this course which boost the knowledge of the students in these fields. The chemistry of industrially important inorganic materials such as cement, ceramics, glass and inorganic fertilizers has been incorporated in the course to enhance the skills and capability of the

students pursuing this course. The students will also be able to understand the analytical techniques such as electro-gravimetric analysis, coulometric analysis, thermogravimetry, polarography and chromatography.

- ✓ Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
- ✓ Students will be able to function as a member of an interdisciplinary problem solving team.
- ✓ Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
- ✓ Students will gain an understanding of how to determine the structure of organic molecules using UV, IR and NMR spectroscopic techniques.

<b>Credits:4</b>	<b>Compulsory</b>
Max. Marks: 25+75	Min. Passing Marks: 33

Total Number of Hours = 60

Unit	Contents	Number of Hours
1	<b>General Biochemistry:</b> Introduction to biomolecules, Enzymes; Definition, classification, role in physiology. General introduction to hormones. Nucleic acids; Nitrogen bases, purines, pyrimidines, nucleosides, nucleotides, structure of RNA and DNA molecule.	12
2	<b>Data Analysis:</b> Errors; Definition, types of errors, precision, accuracy, absolute, Significant Figures; significant figures in Arithmetics-addition, subtraction, multiplication and division, Mean and Standard deviation, Standard deviation and probability.	10
3	<b>Fundamentals of Nanochemistry:</b> Definition, brief history, classification, general approach of nano synthesis, general methods of characterization, general applications.	9
4	<b>Basics of Green Chemistry:</b> Introduction, role of green chemistry in sustainable development, principles of green chemistry.	8
5	<b>Analytical Techniques:</b> Basic concepts of electro-gravimetric and coulometric analysis. Thermogravimetric analysis. Voltametry; principle of polarography  Chromatography: Introduction, Types, paper and column chromatography	9
6	<b>Spectroscopy:</b> Ultraviolet (UV) absorption spectroscopy-absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation, concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated enes and enones.	12



	<p>Infra-Red (IR) absorption spectroscopy- molecular vibrations, Hooke's Law, selection rules, intensity and position of IR bands, measurement of IR spectrum, finger print region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds. Nuclear magnetic resonance (NMR) spectroscopy; Proton magnetic resonance (<sup>1</sup>H NMR) spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of <sup>1</sup>H NMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone, Problems pertaining to the structure elucidation of simple organic compounds using UV, IR and <sup>1</sup>H NMR spectroscopic techniques</p>	
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**Books Recommended:**

- i. Clark, J. H., and Macquarrie, D.J., Handbook of Green Chemistry and Technology, Wiley-Blackwell, 2002.
- ii. Anastas, P.T., and Williamson, T.C. Green Chemistry: Frontiers in Benign Chemical Syntheses and Processes, Oxford University Press, New York, 1999.
- iii. Ozin, G.A., Arsenault, A.C. and L. Cademartiri, Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry, 2008, 2<sup>nd</sup> edition.
- iv. P. H. Raven, Biology, Tata MacGraw Hill.
- v. P. Sheeler, Cell and Molecular Biology, John Wiley.
- vi. N. A. Campbell, Biology Pearson.
- vii. L. Styer, Biochemistry, Freeman & Co.
- viii. Outlines of biochemistry. Fourth edition (Conn, Eric E.; Stumpf, P. K.). Wiley India Pvt. Limited

**Suggested online links:**

1. <https://www.youtube.com/watch?v=qJMJUtgVUVw>
2. <https://www.youtube.com/watch?v=58pAYgrZjF0&t=26s>
3. [https://onlinecourses.nptel.ac.in/noc19\\_mm21/preview](https://onlinecourses.nptel.ac.in/noc19_mm21/preview)
4. <https://www.classcentral.com/course/swayam-introduction-to-data-analytics-3973>
5. [https://onlinecourses.nptel.ac.in/noc21\\_cy26/preview](https://onlinecourses.nptel.ac.in/noc21_cy26/preview)
6. <https://www.classcentral.com/course/swayam-biochemistry-5229>
7. [https://onlinecourses.nptel.ac.in/noc19\\_cy18/preview](https://onlinecourses.nptel.ac.in/noc19_cy18/preview)

**Suggested Continuous Evaluation Methods:** 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 oral presentations.

Evaluation method	Marks
Home assignments/ group discussions/ oral presentations	10 marks
Mid-term evaluation (written test)	10 marks
Attendance	05 marks

**Course prerequisites:** To study this course, a student must have passed Sem-V Theory papers.

### Semester-VI, Paper-III (Practical)

Course Title: Analytical Procedures-IV

<b>Programme/Class:</b> Certificate in Introductory/General Chemistry	<b>Year:</b> Third	<b>Semester:</b> Sixth
Paper-III Practical Subject: Chemistry		
<b>Course Code:</b>	<b>Course Title:</b> Analytical Procedures-IV	

**Course outcomes:** Upon completion of this course, the students will have the knowledge and skills to determine the heat of neutralization, solubility of organic compounds by titration method. They will be able to estimate different metal ions through gravimetric exercise. Spectroscopic and chromatographic exercise will train them to interpret the spectral data and chromatograms of organic compounds and will make them job ready for suitable industries.

<b>Credits:</b> 2	<b>Compulsory</b>
Max. Marks: 10+40	Min. Passing Marks: 17

Total Number of Hours = 60

Unit	Contents	Number of Hours
1	Laboratory hazards and safety precautions	6
2	<b>Physical exercise:</b> Determination of solubility of organic compound (viz. oxalic acid) in water by titration method.  Determination of Heat of neutralization.	18
3	<b>Spectroscopic exercise:</b> Functional Group determination by UV and IR Spectroscopy; analysis of organic compounds including alcohols, phenols, carboxylic acids, carbonyl compounds, nitrogen containing compounds.	18
4	<b>Inorganic Exercise:</b> Gravimetric analysis of any one or two metal ions; Ba <sup>2+</sup> , Fe <sup>3+</sup> , Ni <sup>2+</sup> , Cu <sup>2+</sup> , Zn <sup>2+</sup> etc.	10
5	<b>Chromatographic technique:</b> Demonstrative Chromatography- paper chromatography (Analytical separation of organic compounds- Amino acids/ dyes)	8

**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in viva voce, record and overall performance.

Evaluation method	Marks
Attendance	05 marks
Viva voce/Record and overall performance	05 marks

**Course prerequisites:** To study this course, a student must have opted Sem-VI Theory Paper-1 &2

One exercise each from inorganic analysis (quantitative), Spectroscopy/ Chromatography and physical exercise shall be given in the examination.

**Distribution of marks shall be as given below:**

1. Inorganic salt analysis	12
2. Organic exercise	08
3. Physical	10
4. Viva	05
5. Lab record	05
6. Home assignment/internal assessment, lab record and attendance	10
<b>TOTAL</b>	<b>50</b>

**Note:**

- *The lab work of the student has to be evaluated and assessed carefully and periodically. The semester record has to be maintained by the department/college as an official record.*
- *Less than zero mark will not be awarded.*
- *The total number of students to be examined per batch shall not be more than sixty.*
- *Duration of the practical examination shall be of 05(five) hours.*
- *Marks obtained in the practical examination have to be submitted to the Head of the department/ Principal of the College. The Head of the Department/Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, SDSU University, Badshahi Thaul, Tehri (Garhwal).*

**Minor/Elective courses**  
**Semester-I/II**  
**Paper-I (Theory)**  
**Course Title: Basics of Chemistry**

<b>Programme/Class:</b> Certificate in Science	<b>Year:</b> First	<b>Semester:</b> First/Second
		Paper-I Theory Subject: Chemistry
<b>Course Code:</b>	<b>Course Title:</b> Basics of Chemistry	

**Course outcomes:** There is nothing more fundamental to chemistry than the atom and combination of atoms to form molecules by chemical bond. Chemical bonding is the language of logic for chemists. Chemical bonding enables scientists to take the 100-plus elements of the periodic table and combine them in myriad ways to form chemical compounds and materials. The kind of bond present in a molecule decides nature of molecule (ionic or covalent) and its structure (geometry). The formation of molecules via various chemical reactions involve energy. The course will provide basic understanding on atomic structure, formation of compounds, chemical bonding, chemical changes and energy change in the formation of a matter. Students will gain an understanding of;

- ✓ Molecular geometries, physical and chemical properties of the molecules.
- ✓ Current bonding models for simple inorganic molecules in order to predict structures and important bonding parameters.
- ✓ This course gives a broader theoretical picture in multiple stages in an overall chemical reaction.

<b>Credits:4</b>	<b>Compulsory</b>
Max. Marks: 25+75	Min. Passing Marks: 33

Total Number of Hours = 60

Unit	Content	Number of Hours
1	<p><b>Atom and Molecules:</b></p> <p>Bohr's Atomic theory (only postulates), structure of an atom; nuclear particles, atomic number, mass number and Isotopes, Atomic orbitals, filling of electrons in various orbitals-Aufbau energy diagram, Pauli's Exclusion Principle, Hund's rule of maximum multiplicity</p> <p>Measurement- least count, significant figures, their use in simple arithmetic calculations</p>	8
2	<p><b>Ions, Molecules, bonding, molar mass and chemical reactions</b></p> <p>Ions, ionic bond and ionic compounds, Chemical equations, Reactions in aqueous medium- Arrhenius theory of acids and bases, Acid-Base reaction, definition of acid and base, neutralization, Oxidation Reduction reactions-oxidation number, balancing of oxidation reduction reactions</p> <p>Molecules and chemical formulae, molar mass, molar mass and Avogadro's number, Covalent compounds-bonding, VSEPR</p>	18

	concept and geometry, Valence Bond theory, Hybridization, geometry of covalent molecules, Hydrogen bonding	
3	<b>Periodic Properties</b> Periodic table and periodic law, periodic classification of the elements, Periodic relationship among the elements, periodic properties-atomic size, ionization energy, electron affinity, electronegativity	<b>10</b>
4	<b>Gaseous State</b> Pressure of a gas, pressure volume relationship-Boyle's law, the temperature volume relationship-Charle's law, Ideal gas equation	<b>8</b>
5	<b>Thermochemistry</b> Energy changes in chemical reactions, Enthalpy, specific heat, heat capacity- constant volume and constant pressure, Standard enthalpy of formation and reactions	<b>8</b>
6	<b>Hydrocarbons, functional groups</b> Alkanes, alkenes, alkynes, aromatic hydrocarbons. Homologous series, Preparation and properties of ethene and ethyne. Functional groups in organic compounds-alcohols, ethers, aldehydes, ketones and carboxylic acids Electronegativity and polarization of covalent bond; inductive, mesomeric, electromeric effect, hydrogen bonding and its significance Polymers-definition, properties, polyethylene-preparation	<b>8</b>
7	<b>Practical</b> Basic Knowledge of Laboratory equipments, Basic idea of practicals for better understanding of science concepts. (i) pH measurement (ii) Determination of Viscosity/Surface Tension of a liquid	-

#### **Books Recommended:**

- i. Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5<sup>th</sup> edition.
- ii. Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33<sup>rd</sup> edition.
- iii. Madan, R.L., "Chemistry for Degree Students, B. Sc. First Year", S. Chand Publishing, New Delhi, India, 2011, 3<sup>rd</sup> edition.
- iv. Madan, R.D., Malik, U.M. and Tuli, G.D., "Selected topics in Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2010.

- v. Chandra, S., "Comprehensive Inorganic Chemistry" New Age International Publishers, India, 2018, 1<sup>st</sup> edition.
- vi. Prakash, S., Tuli, G.D., Basu, S.K. and Madan, R.D., "Advanced Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2000, Vol 1.
- vii. Bariyar, A., Singh, R.P. and Dwivedi, A., "Text Book for B. Sc. Chemistry I", Anu Books, 2019.
- viii. Finar, I.L., "Organic Chemistry", Pearson Education India, 2002, 6<sup>th</sup> edition.
- ix. Eliel, E.L. and Wilen, S.H., "Stereochemistry of Organic Compounds", Wiley, 1994, 1<sup>st</sup> edition.
- x. Boyd, Morrison and Bhattacharjee, "Organic Chemistry", Pearson Education India, 2010, 7<sup>th</sup> edition.
- xi. Mukerji, S.M., "Reaction mechanism in Organic Chemistry", Laxmi Publications, 2007, 3<sup>rd</sup> edition.
- xii. Singh, Jagdamba and Yadav, L.D.S., "Undergraduate Organic Chemistry" Pragati Prakashan, India, 2011, Vol 1.
- xiii. Loudon, G. Marc, "Organic Chemistry", Oxford University Press, 2008, 4<sup>th</sup> edition.

**Suggested online links:**

1. [https://onlinecourses.nptel.ac.in/noc22\\_cy36/preview](https://onlinecourses.nptel.ac.in/noc22_cy36/preview)
2. [https://onlinecourses.swayam2.ac.in/cec20\\_lb01/preview](https://onlinecourses.swayam2.ac.in/cec20_lb01/preview)
3. <https://www.youtube.com/watch?v=ZeV3V0DjupQ&list=PLmxSS9XYst20arjxnrlpnL0P99AnswmSs>
4. <https://www.youtube.com/watch?v=zGk6VeTfpuE&list=PLmxSS9XYst21tCVcVKQ9nZdW3OO-20iNW>
5. <https://www.youtube.com/watch?v=zUwbVaBaxTY&list=PLmxSS9XYst22fU5l0ryKCEZNxuVkia6-v>
6. <https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm>
7. <https://www.youtube.com/watch?v=AYD7YJqQ0Q&t=23s>
8. <https://www.youtube.com/watch?v=0LaLl1wskEg>

**Suggested Continuous Evaluation Methods:** 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.

Evaluation method	Marks
Home assignments/ group discussions/ oral presentations	10 marks
Mid-term evaluation (written test)	10 marks
Attendance	05 marks

**Course prerequisites:** To study this course, a student must have studied the Science/chemistry of class 10<sup>th</sup>.

**Semester-III/IV**  
**Paper-I (Theory)**  
**Course Title: yet to be decided**

<b>Programme/Class:</b> Diploma in Chemical Science	<b>Year:</b> Second	<b>Semester:</b> Third/Four
Paper-I Theory Subject: Chemistry		
<b>Course Code:</b>	<b>Course Title: .....</b>	

**Course outcomes: .....**






**Sri Dev Suman Uttarakhand University,  
Badsahithaul, Tehri (Garhwal), Uttarakhand**

**Vocational/Skill Development Course-I  
On  
“Cosmetics and Perfumes Chemistry”**



  
**Department of Chemistry  
Pt. Lalit Mohan Sharma SDS Uttarakhand University Campus,  
Rishikesh, Uttarakhand.**

**Vocational/Skill Development Courses**  
**Semester I/II**  
**Paper I (Theory)**  
**Course title: Cosmetics and Perfumes Chemistry**

<b>Programme/Class:</b> Certificate in Science	<b>Year : First</b>	<b>Semester: First</b>
<b>Paper-I Theory Subject : Vocational/Skill Development Course</b>		
<b>Course Code:</b>	<b>Course Title : Cosmetics and Perfumes Chemistry</b>	

**Course Outcomes:** Cosmetics are products designed to cleanse, protect and change the appearance of external parts of our bodies. The key ingredients present in most cosmetics include water, emulsifiers, preservatives, thickeners, moisturisers, colours and fragrances. Ingredients can be naturally occurring or artificial, but any potential impact on our health depends mainly on the chemical compounds they are made of.

Perfumes are the mixture of fragrant essential oils or aroma compounds (fragrances), fixatives and solvents, usually in liquid form, used to give the human body, animals, food, objects, and living-spaces a pleasant scent. Perfumes are essentially a blend of complementary ingredients and essential oils. Therefore, the perfumes are complex combinations of natural and/or man-made substances that are added to many consumer products to give them a distinctive smell.

The salient feature of this programme is the emphasis being laid on the overall development of student with major focus on application and filed work. The course manly focuses on Cosmetics, Advances in cosmetic product development, Perfume Chemistry, Learning of analytical techniques used in cosmetic and perfume industries etc. Students will get many opportunities of interactions with experts in these fields during the course tenure. The students can gain hands on experience in the field while doing internships in industries/research institutes/health sectors etc.

**Course Objectives:** To provide the learner with knowledge of cosmetics and perfumes with respect to the types of formulations, evaluation and regulatory aspects.

**Course Outcome:** Upon completion of the course, the learner shall be able to:

1. Discuss the various raw materials for cosmetics and perfumes.
2. Understand the toxicological aspects.
3. Discuss the various cosmetics products w.r.t. raw materials, large scale manufacturing and functional and physiochemical evaluation.
4. Know the regulatory guidelines and sensorial assessment for cosmetics.

Credits : 02	Compulsory
Max. Marks 25 + 75	Min. Passing Marks:...
Total number of hours = 30	

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Unit	Content	Number of Hours
1	Introduction, history, classifications and sources of cosmetics and perfumes.	6
2	Surfactants and their types; Additives (thickeners, foam stabilizers, pearlescent agents, conditioning agents, etc.) Oil components; Waxes; Silicone oils; Cream bases; Emulsifiers; Humectants; Aerosol Propellants.	08
3	Chemistry and production of essential oils with special reference to the following; Eugenol, Geraniol, Sandalwood oil, eucalyptus oil, rose oil, Jasmone, Civet one, Muscone.	08
4	Psychological benefits, fragrance and mood, aromatic substances, types of aromatic substances, chemical constituents of aromatic substances, odours of substances from vegetable, animal and artificial origin	08

**Suggested Continuous Evaluation Methods:** 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 online tests, home assignments, group discussions or oral presentations.

Evaluation method	Marks
Home assignments/ group discussions/ oral presentations	10 marks
Mid-term evaluation (written test)	10 marks
Attendance	05 marks

**Course prerequisites:** To study this course, a student must have studied the chemistry of class 12<sup>th</sup> standard.

**Suggested Readings:**

1. Earnest Guenther, "The Essential Oils" vol. I Robert E. Kreiger Publishing Co. Huntington, New York, 1972.
2. M.S. Balsem, S.D. Genshon, M.M. Rieger, E. Sagarin, S.J. Strianase, "Cosmetics, Science and Technology, Vol. I, II and III, Wiley-Interscience, A Division of John Wiley and Sons., Inc., New York, London, Sydney, Toronto, 1972, Ed. By M.S. Balsam and M.S. Sagarin.
3. Paul Z. Bedoukian, "Perfumery and Flavouring Synthetics" II Edn, Elsevier Publishing Co., Amsterdam, London, New York, 1967.
4. J. Stephan Jellinick, "Formulation and Functions of Cosmetics", Wiley Interscience, a Division of John Wiley & Sons., Inc.
5. Mareel IBillot, F.V. Wells, "Perfumery Technology" Ellis Harwood Ltd., Harlsted Press, a Division of John Wiley & Sons., Inc. New York, London, 1975.

6. Chemistry and Technology of the Cosmetics and Toiletries Industry ed. By D.F. Williams & W.H. Schmitt, Blackie Academic & Professional, London, 1st Edn., 1992.
7. Harry's Cosmeticology, sixth edn. The principles and Practice of Modern cosmetics, Vol. I by R.G. Harry Chemical Publishing Co., Inc., New York, 1973.
8. H. Panda, Perfumes and Flavours Technology Handbook, Asia Pacific Business Press Inc., 2010, Delhi.
9. N. Board, Handbook on Herbal Products (Medicines, Cosmetics, Toiletries, Perfumes) National Institute of Industrial Research, 2000, New Delhi
10. M. Vimladevi Textbook of herbal Cosmetics, CBS Publishers and Distributors Pvt. Ltd.
11. HimadriPanda, HerbalcosmeticsHandbook.3<sup>rd</sup> revised edition.
12. W.A. Wani, P.F. Iqbal and M.N. Lone, Chemistry of cosmetics and perfumes, Lifestyle & Personal Style Guides.
13. Krik Othmer, Chemical Technology of cosmetics, John Wiley.
14. A.M. Dar and B.A. Dar, Chemistry of cosmetics & Perfumes, Kalyani Publications.
15. S.V. Bhat, B.A. Nagasampagi and M. Sivakumar, Chemistry of Natural Products, Narosa Publication

<b>Programme/Class:</b> Certificate in Science	<b>Year : First</b>	<b>Semester: First</b>
<b>Paper-II Practical Subject : Vocational/Skill Development Course</b>		
<b>Course Code:</b>	<b>Course Title : Cosmetics and Perfumes Chemistry</b>	

**Course Outcomes:** The students will have the knowledge and skill to understand the laboratory methods and test related to inorganic mixtures and Chromatographic techniques. Also, they can understand the preparation of standard solutions and standardization of volumetric apparatus.

Credits : 01	Compulsory
Max. Marks 10 + 40	Min. Passing Marks: 17
Total number of hours = 30	

Unit	Content	Number of Hours
1	Preparation of Standard solutions: 1 Normal, 1 Molar, % w/v solution, % v/v solution. Standardization of volumetric apparatus.	10
2	Analysis of heavy metals- Lead and Mercury. Determination of chlorides and sulphates.	10
3	Paper and Thin Layer Chromatography	10

**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in viva voce, record and overall performance.

Evaluation Method	Marks
Attendance	05



Viva voce/Record and overall performance	05
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**Course prerequisites:** To study this course, a student must have studied the chemistry of class 12<sup>th</sup> standard.

**Distribution of marks shall be as given below**

1. Preparation of Standard Solutions and standardization of volumetric apparatus	12
2. Inorganic analysis	10
3. Paper and Thin Layer Chromatography	08
4. Viva	05
5. Record	05
6. Home assignments/internal assignment, lab record and attendance	10
<b>Total</b>	<b>50</b>

**Note:**

- The lab work of the student has to be evaluated and assessed carefully and periodically.
- The semester lab record has to be maintained by the department/college as an official record.
- Less than zero mark will not be awarded.
- The total number of students to be examined per batch shall not be more than sixty.
- Duration of the practical examination shall be 04(four) hours.

**Suggested Readings:**

1. J. Mendham Vogel's Quantitative Chemical Analysis, Pearson, 2009.
2. S.M. Khopkar, Basic concepts of analytical chemistry, New Age International Publisher, 2009.
3. A.K. Nad, B. Mahapatra and A. Ghoshal, An advanced course in practical Chemistry, New Central Book Agency (P) Ltd
4. Anju Goyal and Harish Kumar, Advanced Techniques of Analytical Chemistry, Bentham Books.
5. Jagdamba Singh, R.K.P.Singh, Jaya Singh, L.D.S. Yadav, I.R. Siddiqui and Jaya Shrivastava, Advanced Practical Chemistry, Pragati Prakashan

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<b>Programme/Class:</b> Certificate in Science	<b>Year : First</b>	<b>Semester: Second</b>
<b>Paper-I Theory Subject : Vocational/Skill Development Course</b>		
<b>Course Code:</b>	<b>Course Title : Cosmetics and Perfumes Chemistry</b>	

Credits : 02	Compulsory
Max. Marks 25 + 75	Min. Passing Marks: 33
Total number of hours = 30	

Unit	Content	Number of Hours
1	Developmental and role of natural products in cosmetic and medicine. Herbs description and morphology of organized and un-organized herbs.	5
2	Different systems of classification of natural excipients, their merits and demerits.	5
3	Adulteration of Natural products : Quantitative & quantitative methods of detection of adulteration.	10
4	Fixatives :- Introduction , sources, classification, chemical composition and uses of following – a. Animal Source :- Civet, Musk, Ambergris b. Resinous Fixatives – Benzoin, Balsams, Myrrh, Cinnamyl Alcohol, Orris, Vanillin. c. Essential Oils fixatives – Sandal wood , lemon, cinnamon, patchouli oil, Phenyl acetaldehyde, vanillin. d. Synthetics fixatives – Diethyl phthalate Benzyl- Benzoate, alcohols Acetophenone, musk-ketone, musk- Ambrette, Heliotropin, hydroxy citronellal, indole.	10

**Suggested Continuous Evaluation Methods:** 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 online tests, home assignments, group discussions or oral presentations.

Evaluation method	Marks
Home assignments/ group discussions/ oral presentations	10 marks
Mid-term evaluation (written test)	10 marks



Attendance	05 marks
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**Course prerequisites:** To study this course, a student must have studied the chemistry of class 12<sup>th</sup> standard.

**Suggested Readings:**

1. Earnest Guenther, "The Essential Oils" vol. I Robert E. Kreiger Publishing Co.  
a. Huntington, New York, 1972.
2. M.S. Balsem, S.D. Genshon, M.M. Rieger, E. Sagarin, S.J. Strianase, "Cosmetics, Science and Technology, Vol. I, II and III, Wiley-Interscience, A Division of John Wiley and Sons., Inc., New York, London, Sydney, Toronto, 1972, Ed. By M.S. Balsam and M.S. Sagarin.
3. Paul Z. Bedoukian, "Perfumery and Flavouring Synthetics" II Edn, Elsevier Publishing Co., Amsterdam, London, New York, 1967.
4. J. Stephan Jellinick, "Formulation and Functions of Cosmetics", Wiley Interscience, a Division of John Wiley & Sons., Inc.
5. Mareel IBillot, F.V. Wells, "Perfumery Technology" Ellis Harwood Ltd., Halrted Press, a Division of John Wiley & Sons., Inc. New York, London, 1975.
6. Chemistry and Technology of the Cosmetics and Toiletries Industry ed. By D.F. Williams & W.H., Schmitt, Blackie Academic & Professional, London, 1st Edn., 1992.
7. Harry's Cosmeticology, sixth edn. The principles and Practice of Modern cosmetics, Vol. I by R.G. Harry Chemical Publishing Co., Inc., New York, 1973.
8. H. Panda, Perfumes and Flavours Technology Handbook, Asia Pacific Business Press Inc., 2010, Delhi.
9. N. Board, Handbook on Herbal Products (Medicines, Cosmetics, Toiletries, Perfumes) National Institute of Industrial Research, 2000, New Delhi
10. M. Vimladevi Textbook of herbal Cosmetics, CBS Publishers and Distributers Pvt. Ltd.
11. HimadriPanda, HerbalcosmeticsHandbook.3<sup>rd</sup> revised edition.
12. W.A. Wani, P.F. Iqbal and M.N. Lone, Chemistry of cosmetics and perfumes, Lifestyle & Personal Style Guides.
13. Krik Othmer, Chemical Technology of cosmetics, John Wiley.
14. A.M. Dar and B.A. Dar, Chemistry of cosmetics & Perfumes, Kalyani Publications.
15. S.V. Bhat, B.A. Nagasampagi and M. Sivakumar, Chemistry of Natural Products, Narosa Publication

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<b>Programme/Class:</b> Certificate in Science	<b>Year : First</b>	<b>Semester: Second</b>
<b>Paper-II Practical Subject : Vocational/Skill Development Course</b>		
<b>Course Code:</b>	<b>Course Title : Cosmetics and Perfumes Chemistry</b>	

**Course Outcomes:** The students will have the knowledge and skill to understand the laboratory methods and test related to determination of pH, viscosity and surface tension. Also, they can understand the Determination and significance of saponification value.

Credits : 01	Compulsory
Max. Marks 10 + 40	Min. Passing Marks: 17
Total number of hours = 30	

Unit	Content	Number of Hours
1	Determination of pH, surface tension and viscosity	10
2	Different methods of extraction for herbal raw materials.	10
3	Determination & significance of saponification value	10

**Suggested Continuous Evaluation Methods:** Students can be evaluated on the basis of score obtained in viva voce, record and overall performance.

Evaluation Method	Marks
Attendance	05
Viva voce/Record and overall performance	05

**Course prerequisites:** To study this course, a student must have studied the chemistry of class 12<sup>th</sup> standard.

Distribution of marks shall be as given below

1. Determination of pH, surface tension and viscosity	10
2. Extraction methods	10
3. Determination & significance of saponification value.	10
4. Viva	05
5. Lab Record	05
6. Home assignments/internal assignment, lab record and attendance	10
<b>Total</b>	<b>50</b>

**Note:**

- The lab work of the student has to be evaluated and assessed carefully and periodically.

- The semester lab record has to be maintained by the department/college as an official record.
- Less than zero mark will not be awarded.
- The total number of students to be examined per batch shall not be more than sixty.
- Duration of the practical examination shall be 04(four) hours.

**Suggested Readings:**

1. J. Mendham Vogel's Quantitative Chemical Analysis, Pearson, 2009.
2. S.M. Khopkar, Basic concepts of analytical chemistry, New Age International Publisher, 2009.
3. A.K. Nad, B. Mahapatra and A. Ghoshal, An advanced course in practical Chemistry, New Central Book Agency (P) Ltd
4. Anju Goyal and Harish Kumar, Advanced Techniques of Analytical Chemistry, Bentham Books.
5. Jagdamba Singh, R.K.P. Singh, Jaya Singh, L.D.S. Yadav, I.R. Siddiqui and Jaya Shrivastava, Advanced Practical Chemistry, Pragati Prakashan
6. Krik Othmer, Chemical Technology of cosmetics, John Wiley.
7. A.M. Dar and B.A. Dar, Chemistry of cosmetics & Perfumes, Kalyani Publications.

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**Vocational/Skill Development Course-II**  
**On**  
**“Organic Spectroscopy”**



**Department of Chemistry**

**Pt. Lalit Mohan Sharma SDS Uttarakhand University Campus,**  
**Rishikesh, Uttarakhand.**



## Vocational/Skill Development Course-II

### Semester I

#### Paper-I (Theory)

Course Title: **BASIC ANALYTICAL CHEMISTRY**

<b>Programme/Class:</b> Certificate in Science	<b>Year: First</b>	<b>Semester: First</b>
<b>Paper-I Theory Subject: Vocational/Skill Development Course</b>		
<b>Course Code</b>	<b>Course Title: BASIC ANALYTICAL CHEMISTRY</b>	

**Course Objectives:** This course is value-based and/or skill-based and is aimed at providing hands-on-training, competencies, skills, etc. This course may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge. Basic analytical techniques will be taught in this course.

**Course outcomes:** After completion of the course, the student shall be able to-

Characterize/test various organic/inorganic molecules using different analytical techniques.

Distinguish two different compounds using various analytical techniques.

Learn various sampling methods and can work as a sample analyst

Credits: 04	Compulsory
Max. Marks: 25 + 75	Min. Passing Marks: 33
Total Number of Hours : 30	

#### Unit- 1:(6 Hrs)

**Concept of sampling.** Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

#### Unit- 2.(6 Hrs)

**Analysis of soil:** Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators a. Determination of pH of soil samples. b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

#### Unit- 3.(6 Hrs)

**Analysis of water:** Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. a. Determination of pH, acidity and alkalinity of a water sample. b. Determination of dissolved oxygen (DO) of a water sample.

#### Unit- 4.(6 Hrs)

**Analysis of food products & Analysis of cosmetics:** Nutritional value of foods, idea about food processing and food preservations and adulteration.

- Identification of adulterants coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.

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- b. Analysis of preservatives and colouring matter.
- c. Major and minor constituents of Analysis of cosmetics and their function- sulphate.
- Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride.
  - Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

**Unit- 5: (6 Hrs)**

**Chromatography:** Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.

- Paper chromatographic separation of mixture of metal ion ( $Fe^{3+}$  and  $Al^{3+}$ ).
- To compare paint samples by TLC method.
- Determination of ion exchange capacity of anion / cation exchange resin by batch procedure
- d). Spectrophotometric determination of Iron in Vitamin / Dietary Tablets / Caffeine and Benzoic Acid in Soft Drink.

Evaluation method	Marks
Home assignments/ group discussions/ oral presentations	10 marks
Mid-term evaluation (written test)	10 marks
Attendance	05 marks

**Reference:**

- Willard, H. H. Instrumental Methods of Analysis, CBS Publishers.
- Skoog & Lerry. Instrumental Methods of Analysis, Saunders College Publications, New York.
- Skoog, D.A.; West, D.M. & Holler, F.J. Fundamentals of Analytical Chemistry 6th Ed., Saunders College Publishing, Fort Worth (1992).
- Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India.
- Vogel, A. I. Vogels Qualitative Inorganic Analysis 7th Ed., Prentice Hall.

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## Vocational/Skill Development Course-II

### Semester II

#### Paper-I (Theory)

#### Course Title: Organic Spectroscopy

Programme/Class: Certificate in Science	Year: First	Semester: Second
Paper-I Theory Subject: Vocational/Skill Development Course		
Course Code	Course Title: Organic Spectroscopy	

**Course Objectives:** Spectroscopy is the demand of the day, this course will make student familiar with different Spectroscopic methods, so the he/she may be able to characterize and identify various compounds that are synthesized in laboratory or isolated from plants or any other source. Basic spectroscopic techniques along with their spectral characterization will be taught in this course.

**Course outcomes:** After completion of the course, the student shall be able to-

1. Characterize various organic molecules using different spectroscopic techniques.
2. Distinguish two different compounds by comparing their various spectroscopic data.

Credits: 04	Compulsory
Max. Marks: 25 + 75	Min. Passing Marks: 33
Total Number of Hours : 30	

#### UNIT-1: Ultraviolet -Visible absorption spectroscopy: (8 Hrs)

Merits of spectroscopic analysis, Electromagnetic radiation, Wavelength, frequency, wave number and their relation, Absorption spectra, absorbance, Absorption laws-Beers, Lambert Law and Beer-Lambert Law, molar absorptivity, Presentation of UV spectra, types of electronic transitions, Concept of chromophore and auxochrome, Effect of solvents (polarity) and conjugation on absorption maxima, Bathochromic (Red Shift), hypsochromic (Blue Shift), hyperchromic and hypochromic effect, UV spectra of dienes and Woodward—Fieser Rules, Applications of UV- visible spectroscopy

#### UNIT-2: Infrared (IR) absorption spectroscopy: (08 Hrs)

Introduction, IR active and in-active molecules, Molecular vibrations - stretching and bending vibrations, Fundamental bands, Vibrational transitions and degree of freedom, Hookes Law, selection rules, intensity and position of IR bands, Factors affecting vibrational frequencies, Fermi resonance, Instrumentation, measurement of IR spectrum, solvents, Functional Groups region, fingerprint region, Characteristic absorptions of various functional groups, Interpretation of IR spectra of simple organic compounds, Applications of IR spectroscopy.

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### UNIT-3: Nuclear Magnetic Resonance Spectroscopy (NMR): (10 Hrs)

Principle of Protonmagnetic resonance spectroscopy, Origin of Signal, Number signals-equivalent and non-equivalent protons, Position of signals - shielding and deshielding of protons, Peak area and proton counting , Chemical shift, units, scales,  $\delta$  values of different types of protons, factors affecting  $\delta$ ., Splitting of Signals - Spin — Spin Coupling ,coupling constants, magnetic equivalence of protons, Applications of NMR Spectroscopy. Interpretation of PMR spectra of ethanol, acetaldehyde, ethyl bromide, n-propyl bromide, isopropyl bromide, 1, 1-dibromoethane, 1, 1, 2- tribromoethane, etyl acetate, toluene, benzaldehyde and acetophenone.

### UNIT-4: Structure Elucidation: (4 Hrs)

Structure elucidation of organic molecules on the basis of UV-Visible, IR, NMR Spectral data, chemical properties and molecular weight..

Evaluation method	Marks
Home assignments/ group discussions/ oral presentations	10 marks
Mid-term evaluation (written test)	10 marks
Attendance	05 marks

### References:

1. Morrison, R.T. and Boyd, R.T.; Organic Chemistry, Pearson Education
2. Soloman, Fundamentals of Organic Chemistry, Wiley
3. Dhawan, Organic Chemistry, Vol III, Pradeep Publication
4. Y.R. Sharma, Spectroscopy, S. Chand Co, New Delhi
5. Jagdamba Singh, UGC Organic Chemistry Vol III, Pragati Prakashan , Meerut
6. Jagmohan; Organic Spectroscopy

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# **NATIONAL EDUCATION POLICY-2020**

## **Syllabus for First Three Years of Higher Education**



**Sri Dev Suman Uttarakhand University  
Badshahi Thaul (Tehri Garwal) Uttarakhand -249199**

**(State University of Uttarakhand)**

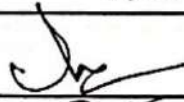
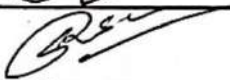

# **MATHEMATICS**

**2022**





**DEPARTMENT COMMITTEE**  
**Pt. L. M. S. Campus, Sri Dev Suman Uttarakhand University,**  
**Rishikesh (Uttarakhand)**





S.No.	Name	Signature
1	Prof. Anita Tomar Head, Department of Mathematics, Pt. L. M. S. Campus, Sri Dev Suman Uttarakhand University, Rishikesh (Uttarakhand)-249201	
2	Dr. Deepa Sharma, Associate Professor, Department of Mathematics, Pt. L. M. S. Campus, Sri Dev Suman Uttarakhand University, Rishikesh (Uttarakhand)-249201	
3	Dr. Gaurav Varshney, Assistant Professor, Department of Mathematics, Pt. L. M. S. Campus, Sri Dev Suman Uttarakhand University, Rishikesh (Uttarakhand)-249201	
4	Dr. Dharendra Singh, Assistant Professor, Department of Mathematics, Pt. L. M. S. Campus, Sri Dev Suman Uttarakhand University, Rishikesh (Uttarakhand)-249201	

## Curriculum Design Committee, Uttarakhand






Sr.No.	Name & Designation	
1.	Prof. N.K. Joshi Vice-Chancellor , Kumaun University Nainital	Chairman
2.	Prof. O.P.S. Negi Vice-Chancellor , Uttarakhand Open University	Member
3.	Prof. P. P. Dhyani Vice-Chancellor , Sri Dev Suman Uttarakhand University	Member
4.	Prof. N.S. Bhandari Vice-Chancellor, Soban Singh Jeena University Almora	Member
5.	Prof. Surekha Dangwal Vice-Chancellor, Doon University, Dehradun	Member
6.	Prof. M.S.M. Rawat Advisor, Rashtriya Uchchatar Shiksha Abhiyan, Uttarakhand	Member
7.	Prof. K. D. Purohit Advisor, Rashtriya Uchchatar Shiksha Abhiyan, Uttarakhand	Member



### SYLLABUS EXPERT COMMITTEE

S. No.	Name	Signature
1	Prof. Anita Tomar, HoD, Department of Mathematics, Sri Dev Suman Campus, Rishikesh	
2	Prof. Jaya Upreti, HoD, Department of Mathematics, S. S. J. Campus, Almora	
3	Dr. Shankar Kumar, Assistant Professor, Department of Mathematics, Govt. P. G. College, Ranikhet.	
4	Dr. Sundar Kumar Arya, Assistant Professor, Department of Mathematics, Govt. P. G. College, Pithoragarh.	

### SYLLABUS PREPRATION COMMITTEE

S. No.	Name	Signature
1	Prof. Jaya Upreti, HoD, Department of Mathematics, S. S. J. Campus, Almora	
2	Prof. Anita Tomar, HoD, Department of Mathematics, Sri Dev Suman Campus, Rishikesh	
3	Dr. Shankar Kumar, Assistant Professor, Department of Mathematics, Govt. P. G. College, Ranikhet.	
4	Dr. Sundar Kumar Arya, Assistant Professor, Department of Mathematics, Govt. P. G. College, Pithoragarh.	
5	Dr. Anita Kumari, Assistant professor, Department of Mathematics, D. S. B. Campus, Almora.	

## Theory and Practical Examination Pattern

theory (External) each theory paper carrying maximum marks 75 and shall consist of two sections A and B. Examination duration shall be 02 hours.

- a. Section A: Multiple choice questions (MCQ)/true and false/very very short answer type questions.  
Section A will consist of 10 questions, each of one mark)  
Total:  $10 \times 1 = 10$  Marks
- b. Section B: (Short answers type)  
Section B will consist of 08 questions, each of 7 marks in which 5 has to be answered.  
Total:  $7 \times 5 = 35$  Marks
- c. Section C: (Long answers type)  
Section C will consist of 3 long answered questions, in which has to be answered, each of 15 marks.  
Total:  $2 \times 15 = 30$  marks

For each theory paper internal assessment shall be conducted periodically (in the form of class tests and/or assignments/ group discussion/ oral presentation/ overall performance) during the semester period. Total marks allotted to internal assessment shall be 25 (Assignments 10 marks, written test/viva.10 marks and regularity 5 marks). The evaluated answer sheets/assignments have to be retained by the Professor In-Charge for the period of six months and can be shown to the students if students want to see the evaluated answer sheets. The marks obtained by the students shall be submitted to the Head of concerned department/ the Principal of the College for uploading onto the University examination portal.

Practical The laboratory work of the students has to be evaluated periodically.

The internal assessment (in the form of lab test, lab record, internal evaluation, assignment/home assignment and attendance) of total 10 marks for each semester shall be conducted during the semester. All kinds of exercises have to be conducted during a semester. Maximum 5 marks of attendance can be given to the students.

In each semester practical examination of 40 marks has to be conducted by two examiners (External and internal) having duration of 4 hours. The total number of students to be examined per batch should not be more than sixty. Marks obtained in the practical examination have to be submitted to the Head of the department/ Principal of the College. The Head of the Department/Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, Sri Dev Suman Uttarakhand University, Badshahithaul, New Tehri.

The breakup of marks for practical examination for each semester would be as follows: .

Practical exam:	30 Marks (exercises)
Viva voce:	05 Marks
Lab Record and collection:	05 Marks
Sessional (Internal):	10 Marks
Total:	50 marks (each semester)

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**Syllabus under NEP-2020**  
 Sri Dev Suman Uttarakhand University  
 Badshahi Thaul (Tehri Garwal)Uttarakhand -249199  
 Session: 2022-23  
**B.A./B.Sc.( Mathematics)**

	Semester	Major	Minor/Additional/Interdisciplinary subject/Multidisciplinary	Skill/Vocational Course-I
Certificate	I	Matrices, Trigonometry and Differential Calculus <b>Credit: 4+2</b>	Differential Calculus <b>Credit: 4</b>	Matrices <b>Credit: 3</b>
	II	Integral Calculus and Vector Analysis <b>Credit: 6</b>		Integral Calculus <b>Credit: 3</b>
Diploma	III	Group Theory and Analytical Geometry <b>Credit: 6</b>	Analytical Geometry <b>Credit: 4</b>	Group Theory <b>Credit: 3</b>
	IV	Ordinary Differential Equations and Ring Theory <b>Credit: 6</b>		Ordinary Differential Equations <b>Credit: 3</b>
Degree	V Paper I	Real Analysis, Functions of several variables and Partial Differential Equations <b>Credit: 5</b>		
		Paper II	Mathematical Methods and Graph Theory/ Number Theory and Relativity/ Numerical Analysis and Operations Research <b>Credit: 5</b>	
	VI Paper I	Complex Analysis and Mechanics <b>Credit: 5</b>		
Paper II		Linear Algebra and Metric Spaces <b>Credit: 5</b>		

**SEMESTER WISE TITLES OF THE PAPER IN UG MATHEMATICS COURSE**

YEAR	SEMESTER	COURSE CODE	PAPER TITLE	THEORY/ PRACTICAL	CREDIT
<b>CERTIFICATE COURSE IN BASIC MATHEMATICS</b>					
FIRST YEAR	I	UGMAT101T	Matrices, Trigonometry and Differential Calculus	THEORY	4
		UGMAT102P	Practical	PRACTICAL	2
	II	UGMAT201T	Integral Calculus and Vector Analysis	THEORY	6
<b>DIPLOMA IN MATHEMATICS</b>					
SECOND YEAR	III	UGMAT301T	Group Theory and Analytical Geometry	THEORY	6
	IV	UGMAT401T	Ordinary Differential Equations and Ring Theory	THEORY	6
<b>DEGREE IN MATHEMATICS</b>					
THIRD YEAR	V	UGMAT501T	Real Analysis, Functions of several variables and Partial Differential Equations	THEORY	5
		UGMAT502T	Any one of the following-  (i) Mathematical Methods and Graph Theory (ii) Number Theory and Relativity (iii) Numerical Analysis and Operations Research	THEORY	5
	VI	UGMAT601T	Complex Analysis and Mechanics	THEORY	5
		UGMAT602T	Linear Algebra and Metric Spaces	THEORY	5

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

OVERVIEW

B.A./B.Sc.:I										
PROGRAMME	YEAR	SEMESTER (15 Weeks)	PAPER	CREDIT	PERIODS Per Week	PERIODS (HOURS) For Semester	PAPER TITLE	UNIT (Periods Per Semester)	PREREQUISITE	ELECTIVE (For Other Faculty)
CERTIFICATE COURSE IN BASIC MATHEMATICS	FIRST YEAR	SEMESTER - I	Paper-1	4	4	4x15=60	Matrices, Trigonometry and Differential Calculus Part A: Matrices Part B: Trigonometry Part C: Differential Calculus	Part A Unit I (8) Unit II (7) Unit III (5) Part B Unit IV (6) Unit V (6) Part C Unit VI (7) Unit VII (6) Unit VIII (8) Unit IX (7)	Mathematics in 12 <sup>th</sup>	Engg. and Tech. (UG), Chemistry/Biochemistry/Life Sciences (UG), Economics (UG/PG), Commerce (UG), BBA/BCA, B.Sc. (C.S.)
			Paper-2 Practical	2	2 Lab Periods (2 Hours Each)	2x2x15=60	Practical (Practicals to be done using Mathematica/MATLAB / Maple / Scilab / Maxima etc.)		Mathematics in 12 <sup>th</sup>	Engg. and Tech. (UG), B.Sc. (C.S.)
			Paper-1	6	6	15x6=90	Integral Calculus and Vector Analysis Part A: Integral Calculus Part B: Vector Analysis	Part A Unit I (12) Unit II (11) Unit III (12) Unit IV (11) Part B Unit V (11) Unit VI (12) Unit VII (11) Unit VIII (10)	Mathematics in 12 <sup>th</sup>	Engg. and Tech. (UG), B.Sc. (C.S.)

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**B.A./B.Sc. II**

PROGRAMME	YEAR	SEMESTER (15 Weeks)	PAPER	CREDIT	PERIODS Per Week	PERIODS (HOURS) Per Semester	PAPER TITLE	UNIT (Periods Per Semester)	PREREQUISITE	ELECTIVE (For Other Faculty)
DIPLOMA IN MATHEMATICS	SECOND YEAR	SEMESTER - III	Paper-1	6	6	6x15=90	<b>Group Theory and Analytical Geometry</b> Part A: Group Theory Part B: Analytical Geometry	Part A Unit I (12) Unit II (20) Unit III (13) Part B Unit IV (11) Unit V (12) Unit VI (12) Unit VII (10)	Certificate Course in Basic Mathematics	Engg. and Tech. (UG), B.Sc. (C.S.)
		SEMESTER - IV	Paper-1	6	6	6x15=90	<b>Ordinary Differential Equations and Ring Theory</b> Part A: Ordinary Differential Equations Part B: Ring Theory	Part A Unit I (12) Unit II (11) Unit III (11) Unit IV (11) Part B Unit V (11) Unit VI (10) Unit VII (12) Unit VIII (12)	Certificate Course in Basic Mathematics	Economics (UG/PG), B.Sc. (C.S.) Engineering and Technology (UG), Science (Physics-UG)

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B.A./B.Sc. III

PROGRAMME	YEAR	SEMESTER (15 Weeks)	PAPER	CREDIT	PERIODS Per Week	PERIODS (HOURS) Per Semester	PAPER TITLE	UNIT (Periods Per Semester)	PREREQUISITE	ELECTIVE (For Other Faculty)
DEGREE IN MATHEMATICS	THIRD YEAR	SEMESTER-V	Paper-1	5	5	5x15=75	Real Analysis & Functions of several variables and Partial Differential Equations Part A: Real Analysis Part B: Functions of several variables and Partial Differential Equations	Part A Unit I (8) Unit II (8) Unit III (7) Unit IV (7) Unit V (7) Part B Unit VI (8) Unit VII (8) Unit VIII (7) Unit IX (8) Unit X (7)	Diploma in Mathematics	Engg. And Tech.(UG), Economics (UG/PG), B.Sc.(C.S.)
			Paper-2	5	5	5x15=75	(i) Mathematical Methods & Graph Theory Part A: Mathematical Methods Part B: Graph Theory	Part A Unit I (8) Unit II (10) Unit III (10) Unit IV (9) Part B Unit V (10) Unit VI (10) Unit VII (9) Unit VIII (9)	Diploma in Mathematics	Engg. and Tech.(UG), BCA, B.Sc.(C.S.)

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DEGREE IN MATHEMATICS	THIRD YEAR	SEMESTER-V	Paper-2	5	5	5x15=75	(i) Number Theory & Relativity Part A: Number Theory Part B: Relativity	Part A Unit I (16) Unit II (11) Unit III (12) Part B Unit IV (14) Unit V (12) Unit VI (10)	Diploma in Mathematics	Engg. and Tech. (UG), BCA, B.Sc. (C.S.)
			Paper-2	5	5	5x15=75	(ii) Numerical Analysis & Operations Research Part A: Numerical Analysis Part B: Operations Research	Part A Unit I (9) Unit II (9) Unit III (10) Unit IV (10) Unit V (9) Part B Unit VI (16) Unit VII (12)	Diploma in Mathematics	Engg. and Tech. (UG), Economics(U G/PG), BBA/BCA, B.Sc.(C.S.)
DEGREE IN MATHEMATICS	THIRD YEAR	SEMESTER-VI	Paper-1	5	5	5x15=75	Complex Analysis & Mechanics Part A: Complex Analysis Part B: Mechanics	Part A Unit I (9) Unit II (9) Unit III (10) Unit IV (9) Part B Unit V (10) Unit VI (10) Unit VII (9) Unit VIII (9)	Diploma in Mathematics	Engg. and Tech. (UG), B.Sc.(C.S.)

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DEGREE IN MATHEMATICS	THIRD YEAR	SEMESTER-VI	Paper-2	5	5	5x15=75	Linear Algebra	Part A	Diploma in Mathematics	Engg. and Tech. (UG), B.Sc.(C.S.)
							& Metric Spaces	Unit I (10) Unit II (9) Unit III (9) Unit IV (9) Unit V (9) Part B Unit VI (6) Unit VII (11) Unit VIII (12)		
							Part A: Linear Algebra			
							Part B: Metric Spaces			

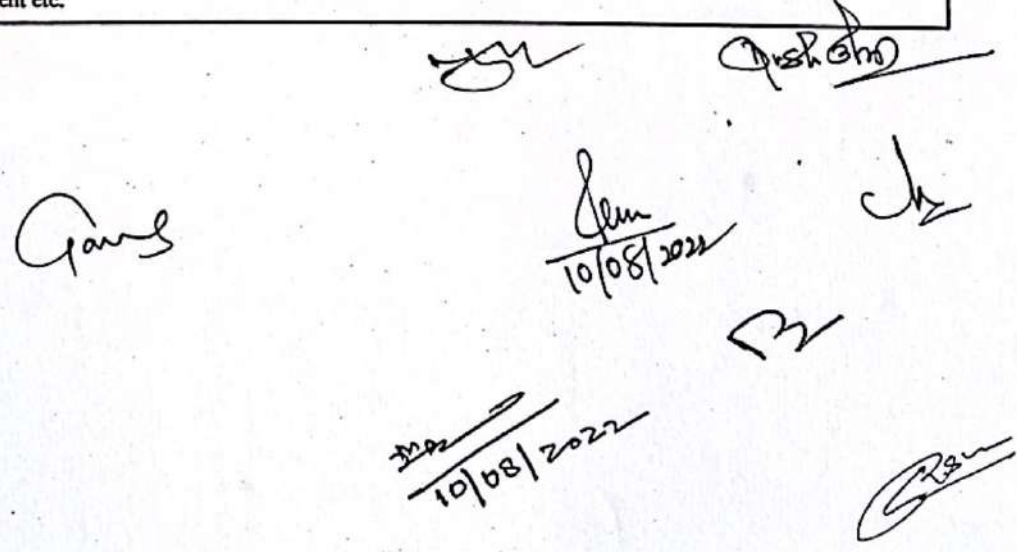
**Programme Outcome/Programme Specific Outcome:**

**Programme Outcome:**

- PO1: It is to give in-depth knowledge of geometry, algebra, calculus, differential equations and several other branches of pure and applied mathematics. This also leads to study the related areas such as computer science and other allied subjects.
- PO2: The skills and knowledge gained in this program will be helpful for modeling and solving of real life problems.
- PO3: Students will become employable in various government and private sector.
- PO4: The completing this programme develop enhanced quantitative skills and pursuing higher mathematics and research as well.
- PO5: The completion of this programme will enable the learner to use appropriate digital programmes and softwares to solve various mathematical problems.

**Programme Specific Outcome:**

- PSO1: Student should be able to think in a critical manner and develop problem solving skills.
- PSO2: Students should be able to recall basic facts about mathematics and display knowledge of conventions such as notations, terminology etc.
- PSO3: Students are able to formulate and develop mathematical arguments in a logical manner.
- PSO4: Students are motivate and prepare for research studies in mathematics and related fields.
- PSO5: Student should be able to apply their skills and knowledge in various fields of studies including, science, engineering, commerce and management etc.


  
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**B.A./B.Sc. I (MATHEMATICS)**

Detailed Syllabus For

**CERTIFICATE**

**COURSE IN**

**BASIC MATHEMATICS**

**B.A. / B.Sc. I (SEMESTER-I) PAPER-I**  
**Matrices, Trigonometry and Differential Calculus**

Programme: Certificate Class: B.A. / B.Sc.	Year: First	Semester: First
Course Code: UGMAT101T	Subject: Mathematics	
Course Title: Matrices, Trigonometry and Differential Calculus		
<p>Course outcomes:</p> <p>CO1: The programme outcome is to give foundation knowledge for the students to understand basics of mathematics including applied aspect for developing enhanced quantitative skills and pursuing higher mathematics and research as well.</p> <p>CO2: By the time students complete the course they will have wide ranging application of the subject and have the knowledge of matrices and basics of differentiation.</p> <p>CO3: The student will be able to sum the trigonometric series of real and complex numbers and separate the trigonometric function in form of <math>A+iB</math>.</p> <p>CO4: The main objective of the course is to equip the student with necessary analytic and technical skills. By applying the principles of differentiation, he learns to solve a variety of practical problems in science and engineering.</p> <p>CO5: The student is equipped with standard concepts and tools at an intermediate to advance level that will serve him well towards taking more advance level course in mathematics.</p>		
Credits: 4	Core Compulsory / Elective	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials – Practical (in hours per week): L-T-P:4-0-0		
<b>Part-A</b> <b>Matrices</b>		
Unit	Topics	No. of Lectures
I	Matrix introduction, matrix operations with their properties, symmetric, skew-symmetric, Hermitian and skew- Hermitian matrices, idempotent, nilpotent, involutory, orthogonal and unitary matrices, singular and non-singular matrices, elementary operations on a matrix, adjoint and inverse of a matrix, singular and non-singular matrices, negative integral powers of a non-singular matrix, Trace of a matrix.	8
II	Rank of a matrix, elementary transformations of a matrix and invariance of rank through elementary transformations, normal form of a matrix, elementary matrices, rank of the sum and product of two matrices, inverse of a non-singular matrix through elementary row transformations, equivalence of matrices.	7
III	Solutions of a system of linear equations, condition of consistency and nature of the general solution of a system of linear non-homogeneous equations.	5

<b>Part-B</b> <b>Trigonometry</b>		
Unit	Topics	No. of Lectures
IV	Trigonometric or circular and hyperbolic function of complex variable together with their inverses, De Moivre's Theorem and its applications, Euler's theorem, relation between trigonometric and hyperbolic function, Exponential function of a complex variable, Logarithms of complex variable, Properties of logarithmic function, Separation into real and imaginary parts	6
V	Gregory's series, Value of $\pi$ by different series, Summation of Trigonometric series by C+HS method based on Arithmetic Progression, Geometric Progression, Logarithms and Binomial expansions, Summation of Trigonometric series by difference method.	6

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**Part-C**  
**Differential Calculus**

Unit	Topics	No. of Lectures
VI	Functions of one variable, Limit of a function ( $\epsilon$ - $\delta$ Definition), Continuity of a function, Properties of continuous functions, Intermediate value theorem, Classification of discontinuities, Differentiability of a function, Jacobians, maxima and minima of single variable function, Rolle's Theorem, Mean value theorems and their geometrical interpretations, Applications of mean value theorems.	7
VII	Successive Differentiation, $n^{\text{th}}$ Differential coefficient of functions, Leibnitz Theorem, Taylor's Theorem, Maclaurin's Theorem, Taylor's and Maclaurin's series expansions.	6
VIII	Geometrical meaning of tangent, Definition and equation of Tangent, Tangent at origin, Angle of intersection of two curves, Definition and equation of Normal, Cartesian sub tangent and subnormal, Tangents and normals of polar curves, Angle between radius vector and tangent, Perpendicular from pole to tangent, Pedal equation of curve, Polar sub tangent and polar subnormal, Derivatives of arc (Cartesian and polar formula).	8
IX	Curvature, Radius of curvature, Cartesian, Polar and pedal formula for radius of curvature, Tangential polar form, Centre of curvature, Asymptotes of algebraic curves, Methods of finding asymptotes, Parallel asymptotes, existence and classification of singular points, points of inflection.	7

**Suggested Readings (PART-A Matrices):**

1. Hari Kishan, A Textbook of Matrices, Atlantic Publishers, 2008
2. Fuzhen Zhang, Matrix Theory- Basic Results and Techniques, Springer, 1999
3. Shanti Narayan, P.K. Mittal, A Textbook of Matrices, S Chand & Company, 2010
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs

**Suggested Readings (PART-B Trigonometry):**

1. Margaret L. Lial, John Hornsby, David I. Schneider, Trigonometry, Addison-Wesley, 2001
2. Robert Moyer, Frank Aryes, Schaum's Outline of trigonometry, 2012
3. I. M. Gelfand, Mark Saul, Trigonometry, Birkhäuser, 2001st edition (June 8, 2001)
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs

**Suggested Readings (Part- C Differential Calculus):**

1. R.G. Bartle & D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons, 1999
2. T.M. Apostol, Calculus Vol. I, John Wiley & Sons Inc., 1974
3. Ajit Kumar and S. Kumaresan, A Basic Course in Real Analysis, CRC Press, 2019
4. S. Balachandra Rao & C. K. Shantha, Differential Calculus, New Age Publication, 1992
5. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc. 2007
6. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2010
7. Suggested digital platform: NPTEL/SWAYAM/MOOCs

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), Chemistry/ Biochemistry/ Life Sciences (UG), Economics (UG/PG), Commerce (UG), BBA/ BCA, B.Sc. (C.S.)

**Suggested Continuous Evaluation Methods: Max. Marks: 25**

S.N.	Assessment Type	Max. Marks
1	Class Tests	10
2	Online Quizzes/Objective Tests	5
3	Presentation	5
4	Assignment	5

Course prerequisites: To study this course a student must have subject Mathematics in class 12<sup>th</sup>.

Suggested equivalent online courses:

Further Suggestions:

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**B.A./B.Sc. I (SEMESTER-I) Paper-II**

**Practical**

Programme: Certificate		Year: First		Semester: First	
Class: B.A./B.Sc.		Subject: Mathematics			
Course Code: UGMAT102P		Course Title: Practical			
Course outcomes:					
CO1: The main objective of the course is to familiar the student with different computer software such as Mathematica /MATLAB /Maple /Scilab/Maxima etc.					
CO2: The students will be able to compute various operations on matrices by using different computer software such as Mathematica /MATLAB /Maple /Scilab/Maxima etc.					
CO2: The students will also be able to compute $n^{\text{th}}$ derivative of various functions by using different computer software.					
Credits:2		Core Compulsory/Elective			
Max. Marks: 25+75		Min. Passing Marks:			
Total No. of Lectures – Tutorials – Practical (in hours per week): L-T-P: 4-0-0					
Unit	Topics				Nd. of Lectures
	Practical / Lab work to be performed in Computer Lab. List of the practical to be done using R/Python/Mathematica/MATLAB/Maple/Scilab/Maxima etc.				
	<ol style="list-style-type: none"> <li>1. Introduction to the software and commands related to the topic.</li> <li>2. Computation of addition and subtraction of matrices,</li> <li>3. Computation of multiplication of matrices.</li> <li>4. Computation of Trace and Transpose of Matrix.</li> <li>5. Computation of Rank of matrix.</li> <li>6. Computation of Inverse of a Matrix.</li> <li>7. Solving the system of homogeneous and non-homogeneous linear algebraic equations.</li> <li>8. Finding the <math>n^{\text{th}}</math> Derivative of <math>e^{ax}</math>, trigonometric and hyperbolic functions.</li> <li>9. Finding the <math>n^{\text{th}}</math> Derivative of algebraic and logarithmic functions.</li> <li>10. Finding the <math>n^{\text{th}}</math> Derivative of <math>e^{ax}\sin(bx + c)</math>, <math>e^{ax}\cos(bx + c)</math>.</li> <li>11. Finding the Taylor's and Maclaurin's expansions of the given functions.</li> </ol>				60
Suggested Readings:					
This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), B.Sc. (C.S.)					
Suggested Continuous Evaluation Methods: Max. Marks: 25					
S.N.	Assessment Type				Max. Marks
1	Class Tests				10
2	Online Quizzes/ Objective Tests				5
3	Presentation				5
4	Assignment				5
Course prerequisites: To study this course a student must have subject Mathematics in class 12 <sup>th</sup> .					
Suggested equivalent online courses:					
Further Suggestions:					

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**B.A. / B.Sc. I (SEMESTER-II) PAPER – I**  
**Integral calculus and Vector Analysis**

Programme: Certificate	Year: First	Semester: Second
Class: B.A./B.Sc.		
Course Code: UGMAT201T	Subject: Mathematics	
Course outcomes:	Course Title: Integral calculus and Vector Analysis	
CO1: The Programme outcome is to give foundation knowledge for the students to understand basics of mathematics including applied aspect for developing enhanced quantitative skills and pursuing higher mathematics and research as well.		
CO2: By the time students complete the course they will have wide ranging application of the subject and have the knowledge of surface area and volume of shapes.		
CO3: The main objective of the course is to equip the student with necessary analytic and technical skills. By applying the principles of integral he learns to solve a variety of practical problems in science and engineering.		
CO4: The student is equipped with standard concepts and tools at an intermediate to advance level that will serve him well towards taking more advance level course in mathematics.		
Credits: 6	Core Compulsory/Elective	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures – Tutorials – Practical (in hours per week): L-T-P: 6-0-0		

PART-A		
Integral Calculus		
Unit	Topics	No of Lectures
I	Integral as a limit of sum, Properties of Definite integrals, Fundamental theorem of integral calculus, Summation of series by integration, Infinite integrals, Differentiation and integration under the integral sign.	12
II	Beta function, Properties and various forms, Gamma function, Recurrence formula and other relations, Relation between Beta and Gamma function, Evaluation of integrals using Beta and Gamma functions.	11
III	Double integrals, Repeated integrals, Evaluation of Double integrals, Double integral in polar coordinates, Change of variables, Change of order of integration in Double integrals, Triple integrals, Evaluation of Triple integrals, Dirichlet's theorem and its Liouville's extension.	12
IV	Area bounded by curves (quadrature), Rectification (length of curves), Volumes and Surfaces of Solids of revolution.	11

PART-B		
Vector Analysis		
Unit	Topics	No. of Lectures
V	Triple product, Reciprocal vectors, Product of four vectors, General equation of a Plane, Normal and Intercept forms, Two sides of a plane, Length of perpendicular from a point to a plane, Angle between two planes, System of planes.	11
VI	Direction Cosines and Direction ratios of a line, Projection on a straight line, Equation of a line, Symmetrical and unsymmetrical forms, Angle between a line and a plane, Coplanar lines, Lines of shortest distance, Length of perpendicular from a point to a line, Intersection of three planes, Transformation of coordinates.	12
VII	Ordinary differentiation of vectors, Velocity and Acceleration, Differential operator-Del, Gradient, Divergence and Curl.	11
VIII	Line, Surface and volume integrals, Simple applications of Gauss divergence theorem, Green's theorem and Stokes theorem (without proof).	10

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**Suggested Readings (Part- A Integral Calculus):**

1. T.M. Apostol, Calculus Vol. I, John Wiley & Sons Inc., 1974
2. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc. 2007
3. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2010
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs

**Suggested Readings (Part- B Vector Analysis):**

1. Murray R. Spiegel: Vector Analysis, Schaum's Outline Series, McGraw Hill.
2. N. Saran and S. N. Nigam; Introduction to Vector Analysis, Pothishala Pvt. Ltd. Allahabad.
3. Suggested digital platform: NPTEL/SWAYAM/MOOCs

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), B.Sc. (C.S.)

**Suggested Continuous Evaluation Methods: Max. Marks: 25**

S.N.	Assessment Type	Max. Marks
1	Class Tests	10
2	Online Quizzes/ Objective Tests	5
3	Presentation	5
4	Assignment	5

Course prerequisites: To study this course a student must have subject Mathematics in class 12<sup>th</sup>.

Suggested equivalent online courses:

Further Suggestions:

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**B.A./B.Sc. II (MATHEMATICS)**

Detailed Syllabus For

**DIPLOMA  
IN  
MATHEMATICS**

**B.A./B.Sc. II (SEMESTER-III) PAPER-I Group Theory and Analytical Geometry**

Programme: Diploma Class: B.A./B.Sc.	Year: Second	Semester: Third
Subject: Mathematics		
Course Code: UGMAT301T	Course Title: Group Theory and Analytical Geometry	
Course outcomes:		
<p>CO1: Group theory is one of the building blocks of modern algebra. Objective of this course is to introduce students to basic concepts of Group and their properties.</p> <p>CO2: This course will lead the student to basic course in advanced mathematics and geometry.</p> <p>CO3 The subjects learn and visualize the fundamental ideas about coordinate geometry and learn to describe some of the surface by using analytical geometry.</p> <p>CO4: On successful completion of the course students have gained knowledge about regular geometrical figures and their properties. They have the foundation for higher course in geometry.</p> <p>CO5: On successful completion of the course students should have knowledge about higher different mathematical methods and will help him in going for higher studies and research.</p>		
Credits: 6	Core Compulsory / Elective	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures - Tutorials-Practical (in hours per week): L-T-P:6-0-0		
<p align="center"><b>Part-A</b> <b>Group Theory</b></p>		
Unit	Topics	No. of Lectures
I	Cartesian product of Sets, Functions or mappings, Binary operations, Relation, Equivalence relations and partitions, Congruence Modulo n, Definition of a group with examples and simple properties, Abelian group, Finite and infinite group, Order of a finite group, General properties of groups, Composition table for finite groups	12
II	An Alternative set of postulates of groups, Subgroups, Permutations, Cyclic Permutations, Even and odd permutations, group of Permutations alternating group, Integral power of an element of a group, Order of an element of a group, Group homomorphism, Isomorphism on groups, the relation of isomorphism in the set of all groups Complexes and subgroup of a group, theorems on subgroups, Coset decomposition, Lagrange's theorem and its consequences, Cayley's theorem, Cyclic group, generating system of group.	20
III	Normal subgroups, Simple group, Conjugate elements, Normalizer of an element of a group, Class equation of a group, Centre of a group, Conjugate subgroups, Invariant sub groups, Quotient group, Homomorphism and Isomorphism on groups, Kernel of a Homomorphism and related theorems.	13

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**Part-B  
Analytical Geometry**

Unit	Topics	No. of Lectures
IV	Polar Equation of conics, Polar coordinate system, Distance between two points, Polar equation of a Straight line, Polar equation of a circle, Polar equation of a conic, Chords, Tangent and Normal to a conic	11
V	Curvilinear coordinates, Spherical and Cylindrical coordinates, Definition and equation of a sphere, Plane section of a sphere, Intersection of two spheres, Intersection of a sphere and a line, Power of a point, tangent plane, Plane of contact, Polar plane, Pole, Angle of Intersection of two spheres, Radical plane, Co-axial system of spheres.	12
VI	Definition and equation of a cone, Vertex, Guiding curve, Generators, Three mutually perpendicular generators, Intersection of a line with a cone, Tangent line and tangent plane, Reciprocal cone, Right circular cone, Definition and equation of a cylinder, Right circular cylinder, Enveloping cylinder.	12
VII	General equation of second degree, Tangent plane, Director sphere, Normal, Plane of contact, Polar plane, Conjugate plane and conjugate points	10

**Suggested Readings (Part-A Group Theory):**

1. J. B. Fraleigh, A first course in Abstract Algebra, Addison-wiley, 2003
2. I. N. Herstein, Topics in Algebra, John Wiley & Sons, 2006
3. Thomas W Hungerford, Abstract Algebra—An Introduction, Saunders College Publishing, 1990
4. Joseph A Gallian, Contemporary Abstract Algebra, Brooks/Cole Cengage Learning, 2016
5. V. K. Khanna and S. K. Bhambri, A course in Abstract Algebra, Vikas Publishing House Pvt (Ltd), 2014.
6. Suggested digital platform: NPTEL/SWAYAM/MOOCs

**Suggested Readings (Part-B Analytical Geometry):**

1. Robert J.T Bell, An Elementary Treatise on Coordinate Geometry of three dimensions, Macmillan India Ltd., 1923
2. P.R. Vittal, Analytical Geometry 2d & 3D, Pearson, 2013
3. S.L. Loney, The Elements of Coordinate Geometry, McMillan and Company, London. 2018
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), B.Sc. (C.S.)

**Suggested Continuous Evaluation Methods: Max. Marks: 25**

S.N.	Assessment Type	Max. Marks
1	Class Tests	10
2	Online Quizzes/Objective Tests	5
3	Presentation	5
4	Assignment	5

**Course prerequisites:** To study this course, a student must have Certificate Course in Basic Mathematics.

**Suggested equivalent online courses:**

**Further Suggestions:**

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**B.A./B.Sc. II (SEMESTER-IV) PAPER-I Ordinary Differential Equations and Ring Theory**

Programme: Diploma Class: B.A./B.Sc.	Year: Second	Semester: Fourth
Course Code: UGMAT401T		Subject: Mathematics
Course outcomes:		Course Title: Ordinary Differential Equations and Ring Theory
<p>CO1: The objective of this course is to familiarize the students with various methods of solving differential equations of first and second order and to have qualitative applications.</p> <p>CO2: A student doing this course is able to solve differential equations and is able to model problems in nature using ordinary differential equations. After completing this course, a student will be able to take more courses on wave equation, heat equation, diffusion equation, gas dynamics, nonlinear evolution equation etc.</p> <p>CO3: Ring theory is one of the building areas of modern algebra. Objective of this course is to introduce students to basic concepts of Ring, Integral domain and other structures with their properties. This course will lead the student to basic course in advanced mathematics and Algebra.</p>		
Credits: 6	Core Compulsory/Elective	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures - Tutorials-Practical (in hours per week): L-T-P:6-0-0		
Part-A		
Ordinary Differential Equations		
Unit	Topics	No. of Lectures
I	Introduction of Differential equations, Order and Degree of Differential Equations, Complete primitive (general solution, particular solution and singular solutions), Existence and uniqueness of the solution $dy/dx = f(x,y)$ .	12
II	Differential equations of first order and first degree, Separation of variables, Homogeneous linear Equations, Exact Equations, Integrating Factor, Linear Equation, Equation of First order but not of first degree, Various methods of solution, Clairaut's form, Singular solutions, Trajectory, Orthogonal Trajectory, Self-Orthogonal family of Curves.	11
III	Linear differential equations with constant coefficients, Complementary function, Particular Integral, Working rule for finding solution of linear differential equations with constant coefficients, Homogeneous linear equations or Cauchy-Euler equations.	11
IV	Simultaneous differential equations, Differential equations of the form $dx/P = dy/Q = dz/R$ where P, Q, R are functions of x, y, z. Exact differential equations, Total differential equations, Series solutions of differential equations, Linear differential equations of second order with variable coefficients, Initial and boundary value problems.	11

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**Part-B  
Ring Theory**

Unit	Topics	No. of Lectures
V	Rings, Various types of rings, Rings with unity, Rings without zero divisors, Properties of rings, Sub rings.	11
VI	Ideals, Quotient rings, Principal ideals, Maximal ideals, Prime ideals, Principal ideal domains, Characteristic of a ring.	10
VII	Integral domain, Field, Skew field etc., Field of quotients of an integral domain, Embedding of an integral domain in a field, Factorization in an integral domain, Divisibility, Units, Associates, Prime and irreducible elements, Unique Factorisation Domain, Euclidean rings.	12
VIII	Polynomials over a ring, Degree of a polynomial, Zero, Constant and monic polynomials, Equality of polynomials, Addition and multiplication of polynomials, Polynomial rings, Embedding of a ring $R$ into $R[x]$ , Division algorithm, Euclidean algorithm, Units and associates in polynomials, Irreducible polynomials.	12

- Suggested Readings (Part-A Differential Equations):**
- G.F. Simmons, Differential Equations with Application and Historical Notes, Tata -McGraw Hill, 2002
  - B. Rai, D.P. Choudhary & H. J. Freedman, A Course of Ordinary Differential Equations, Narosa, 2002
  - Ian N. Snedden, Elements of Partial Differential Equations, Dover Publication, 2013
  - L.E. Elsgolts, Differential Equation and Calculus of variations, University Press of the Pacific, 1970
  - M. D. Raisinghanis, Ordinary and Partial Differential Equations, S Chand, 2018.
  - Suggested digital platform: NPTEL/SWAYAM/MOOCs

- Suggested Readings (Part-B Ring Theory):**
- J.B. Fraleigh, A first course in Abstract Algebra, Addison-wiley, 2003
  - I.N. Herstein, Topics in Algebra, John Wiley & Sons, 2006
  - Thomas W Hungerford, Abstract Algebra - An Introduction, Saunders College Publishing, 1990
  - Joseph A Gallian, Contemporary Abstract Algebra, Brooks/Cole Cengage Learning, 2016
  - Suggested digital platform: NPTEL/SWAYAM/MOOCs

This course can be opted as an elective by the students of following subjects: Economics (UG/PG), B.Sc. (C.S.) Engineering and Technology (UG), Science (Physics-UG)

**Suggested Continuous Evaluation Methods: Max. Marks:25**

S.N.	Assessment Type	Max. Marks
1	Class Tests	10
2	Online Quizzes/Objective Tests	5
3	Presentation	5
4	Assignment	5

Course prerequisites: To study this course, a student must have Certificate Course in Basic Mathematics.

Suggested equivalent online courses:

Further Suggestions:

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**B.A./B.Sc. III (MATHEMATICS)**

Detailed Syllabus For

**DEGREE  
IN  
MATHEMATICS**

**B.A./B.Sc. III (SEMESTER-V) PAPER-I Real Analysis, Functions of several variables and Partial Differential Equations.**

Programme: Degree Class: B.A./B.Sc.	Year: Third	Semester: Fifth
Subject: Mathematics		
Course Code: UGMATS01T	Course Title: Real Analysis, Functions of several variables and Partial Differential Equations	
<p>Course outcomes:</p> <p>CO1: Students will be able to know the basic concepts and developments of real analysis which will prepare the students to take up further applications in the relevant fields.</p> <p>CO2: On successful completion of the course students should have knowledge about real analysis and will help him in going for higher studies and research.</p> <p>CO3: The main objective of the course is to equip the student with necessary analytic and technical skills.</p> <p>CO4: The course in partial differential equation intends to develop problem solving skills for solving various types of partial differential equation especially hyperbolic, parabolic and elliptic types of PDE.</p>		
Credits: 5	Core Compulsory / Elective	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0		
<b>PART-A</b>		
<b>Real Analysis</b>		
Unit	Topic	No. of Lectures
I	Continuity and Differentiability of functions: Continuity of functions, Uniform continuity, Differentiability, Taylor's theorem with various forms of remainders.	8
II	Integration: Riemann integral-definition and properties, integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus.	8
III	Sequence and Series: Sequences, theorems on limit of sequences, Cauchy's convergence criterion, infinite series, series of non-negative terms, Absolute convergence, tests for convergence, comparison test, Cauchy's root Test, ratio Test, Rabbe's, Logarithmic test, De Morgan's Test, Alternating series, Leibnitz's theorem.	7
IV	Improper Integrals: Improper integrals and their convergence, Comparison test, Dritchlet's test, Absolute and uniform convergence, Weierstrass M-Test, Infinite integral depending on a parameter.	7
V	Uniform Convergence: Point wise convergence, Uniform convergence, Test of uniform convergence, Weierstrass M-Test, Abel's and Dritchlet's test, Convergence and uniform convergence of sequences and series of functions.	7
<b>PART-B</b>		
<b>Functions of several variables and Partial Differential Equations</b>		
Unit	Topic	No. of Lectures
VI	Functions of several variables: Limit, continuity and differentiability of functions of several variables.	8

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VII	<b>Partial Derivatives:</b> Partial derivatives and their geometrical interpretation, differentials, derivatives of composite and implicit functions, Jacobians, Chain rule, Euler's theorem on homogeneous functions, harmonic functions, Taylor's expansion of functions of several variables.	8
VIII	<b>Maxima and Minima:</b> Maxima and minima of functions of several variables – Lagrange's method of multipliers.	7
IX	<b>Partial differential equations:</b> Partial differential equations of first order, Charpit's method, Linear partial differential equations with constant coefficients. First-order linear, quasi-linear and non-linear PDE's using the method of characteristics: know how to obtain explicit solutions.	8
X	<b>Partial differential equations of 2nd-order:</b> Classification of 2nd-order linear equations in two independent variables: hyperbolic, parabolic and elliptic types (with examples).	7

**Suggested Readings (Part-A Real Analysis):**

1. Walter Rudin: Principle of Mathematical Analysis (3rd edition) McGraw-Hill Kogakusha, 1976, International Student Edition.
2. K. Knopp: Theory and Application of Infinite Series.
3. T. M. Apostol: Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.
4. P. R. Halmos: Naive Set Theory, Van Nostrand, 1960.
5. S. C. Malik and Savita Arora, Mathematical Analysis, New Age International Pvt. (Ltd), 2012.
6. Suggested digital platform: NPTEL/SWAYAM/MOOCs

**Suggested Readings (Part-B Functions of several variables and Partial Differential Equations):**

1. W. Fleming: Functions of several variables, Springer
2. R P Agrawal: Ordinary and Partial Differential Equations, Springer
3. K Sankar Rao: Partial Differential Equations, PHI
4. M. D. Raisinghanis, Ordinary and Partial Differential Equations, S Chand, 2018.
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs

This course can be opted as an elective by the students of following subjects: Engg. And Tech.(UG), Economics (UG/PG), B.Sc.(C.S.)

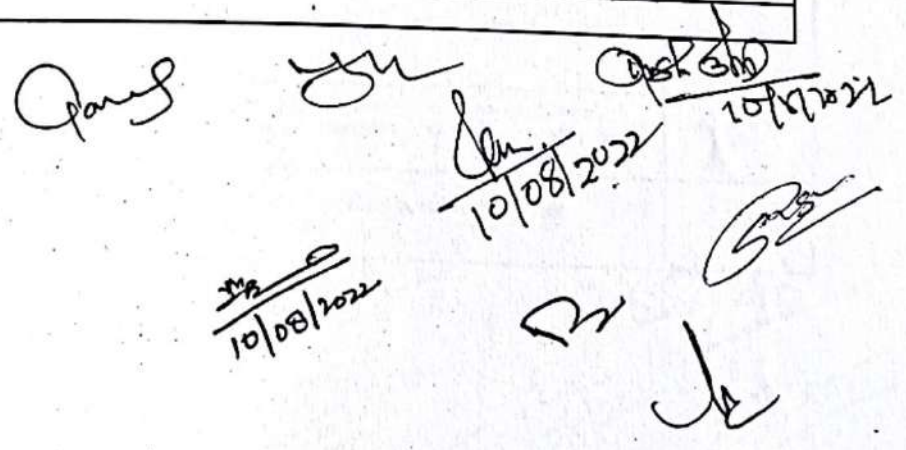
**Suggested Continuous Evaluation Methods: Max. Marks: 25**

S. N.	Assessment Type	Max. Marks
1	Class Tests	10
2	Online Quizzes/Objective Tests	5
3	Presentation	5
4	Assignment	5

Course prerequisites: To study this course, a student must have Diploma in Mathematics.

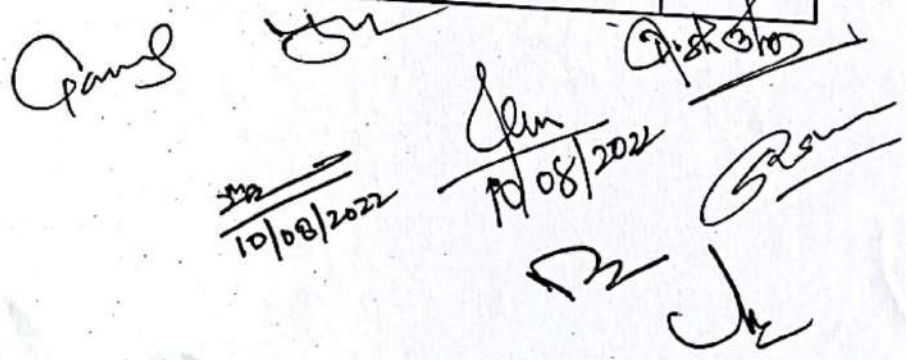
Suggested equivalent online courses:

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## B.A./B.Sc. III (SEMESTER-V) PAPER-II (i) Mathematical Methods and Graph Theory

Programme: Degree Class: B.A./B.Sc.	Year: Third	Semester: Fifth
Course Code: UGMAT502T		Subject: Mathematics
Course Title: Mathematical Methods and Graph Theory		
<p><b>Course outcomes:</b></p> <p>CO1: The student will be able to find the integral transform, Laplace transform, inverse Laplace transform and Fourier transform. The course in mathematical methods basically develops a problem solving skill in the students.</p> <p>CO2: Upon successful completion, students will have the knowledge of various types of graphs, their terminology and applications.</p> <p>CO3: After Successful completion of this course students will be able to understand the isomorphism and homomorphism of graphs. This course covers the basic concepts of graphs used in computer science and other disciplines. The topics include path, circuits, adjacency matrix, tree, coloring. After successful completion of this course the student will have the knowledge graph coloring, color problem, vertex coloring.</p>		
Credits: 5	Core Compulsory / Elective	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0		
<b>PART-A</b>		
<b>Mathematical Methods</b>		
Unit	Topic	No. of Lectures
I	<b>Integral Transforms: Definition, Kernel.</b>	8
II	<b>Laplace Transforms: Definition, Existence theorem, Linearity property, Laplace transforms of elementary functions, Heaviside Step and Dirac Delta Functions, First Shifting Theorem, Second Shifting Theorem, Initial-Value Theorem, Final-Value Theorem, The Laplace Transform of derivatives, integrals and Periodic functions.</b>	10
III	<b>Inverse Laplace transforms: Inverse Laplace transforms of simple functions, Inverse Laplace transforms using partial fractions, Convolution, Solutions of differential and integro-differential equations using Laplace transforms. Dirichlet's condition,</b>	10
IV	<b>Fourier Transforms: Fourier Complex Transforms, Fourier sine and cosine transforms, Properties of Fourier Transforms, Inverse Fourier transforms.</b>	9
<b>PART-B</b>		
<b>Graph Theory</b>		
Unit	Topic	No. of Lectures
V	<b>Introduction to graphs, basic properties of graphs, Simple graph, multi graph, graph terminology, representation of graphs, Bipartite, regular, planar and connected graphs, connected components in a graph, Euler graphs, Directed, Undirected, multi-graph, mixed graph.</b>	10
VI	<b>Walk and unilateral components, unicursal graph, Hamiltonian path and circuits, Graph coloring, chromatics number, isomorphism and homomorphism of graphs, Incidence relation and degree of the graph.</b>	10


  
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VII	Operation of graph circuit, Path and circuits, Eulerian circuits, Hamiltonian path and cycles, Adjacency matrix, Weighted graph, Travelling salesman problem, shortest path, Dijkstra's algorithm.	9
VIII	Tree, Binary and Spanning trees, Coloring, Color problems, Vertex coloring and important properties.	9

**Suggested Readings (Part-A Mathematical Methods):**

1. Murry R. Spiegel: Laplace Transform (SCHAUM Outline Series), McGraw-Hill.
2. J. F. James: A student's guide to Fourier transforms, Cambridge University Press.
3. Ronald N. Bracewell: The Fourier transforms and its applications, McGraw Hill.
4. J. H. Davis: Methods of Applied Mathematics with a MATLAB Overview, Birkhäuser, Inc., Boston, MA, 2004.
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs

**Suggested Readings (Part-B Graph Theory):**

1. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Dover Publications, 2017.
2. Douglas B West, Introduction to Graph Theory, Pearson, 2018.
3. Santanu Saha Ray, Graph Theory with Algorithms and Its Applications: In Applied Science and Technology, Springer India, 2012.
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs

This course can be opted as an elective by the students of following subjects: Engg. and Tech.(UG), BCA, B.Sc.(C.S.)

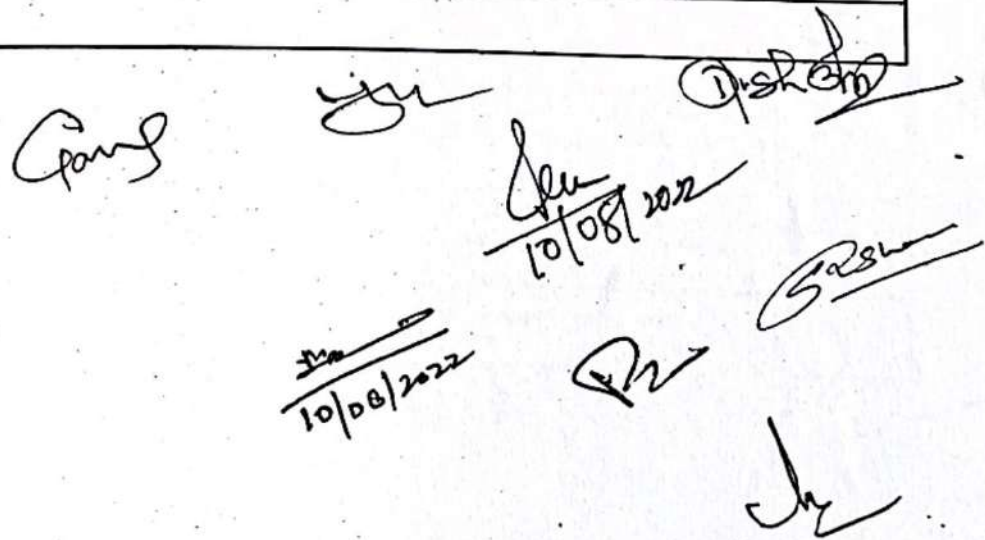
**Suggested Continuous Evaluation Methods: Max. Marks: 25**

S. No	Assessment Type	Max. Marks
1	Class Tests	10
2	Online Quizzes/Objective Tests	5
3	Presentation	5
4	Assignment	5

Course prerequisites: To study this course, a student must have Diploma in Mathematics.

Suggested equivalent online courses:

Further Suggestions:


  
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### B.A./B.Sc. III (SEMESTER-V) PAPER-II (ii) Number Theory and Relativity

Programme: Degree Class: B.A./B.Sc.	Year: Third	Semester: Fifth
Subject: Mathematics		
Course Code: UGMAT502T	Course Title: Number Theory and Relativity	
Course outcomes:		
CO1: The student will be able to solve problems in elementary number theory and also apply elementary number theory to cryptography.		
CO2: Upon successful completion, students will be able to describe the basic concepts of the theory of relativity.		
CO3: After Successful completion of this course students will be able to discuss postulates of the special theory of relativity and their consequences.		
Credits: 5	Core Compulsory / Elective	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0		
<b>PART-A</b>		
Number Theory		
Unit	Topic	No. of Lectures
I	Prime Numbers, Unique Factorization theorem, Farey series, Irrational numbers, Congruences, Residues, Quadratic Reciprocity Law, Primitive roots.	16
II	Fermat's theorem, Wilson's theorem, Continued fractions, Approximation of irrational of rationals, Hurwitz theorem.	11
III	The fundamental theorem of arithmetic in $K(1)$ , $K(i)$ , $K(\rho)$ , Diophantine equation $X^2 + Y^2 = Z^2$ , $X^4 + Y^4 = Z^4$ , $ax^2 + by^2 + cz^2 = 0$ , Quadratic fields, The arithmetic functions: $d(n)$ , $\sigma(n)$ , $\mu(n)$ and $\phi(n)$ including elementary result on their order and average order.	12
<b>PART-B</b>		
Relativity		
Unit	Topic	No. of Lectures
IV	Special Relativity: Inertial Frames of reference, Michelson-Morley experiment, Doppler effect, Stellar aberration, Simultaneity, Postulates of special relativity, Lorentz transformation, Length contraction, Time dilation, Clock paradox, Addition of velocities and accelerations, Four- dimensional space time, Light cone, Mass variation, Velocity four vector, Momentum and force, Mass-Energy relationship.	14
V	General Relativity: Geodesics, Geodesic coordinates, Curvature tensor and its algebraic properties, Bianchi's identities, Contracted curvature tensor, Conditions for a flat space time, Displacement of space-time, Killing equations, Groups of motion, Space-time of constant curvature.	12
VI	Principal of covariance, Non-inertial frames of reference, Principal of equivalence, Weak field approximation of geodesic equations, Law of gravitation in empty space-time, Canonical coordinates, Schwarzschild solutions.	10

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**Suggested Readings (Part-A Number Theory):**

1. G. H. Hardy and E. M. Wright: Introduction to the theory of numbers, Oxford University Press, 4th Edition.
2. D. M. Burton: Elementary Number Theory, 6th Edition, Tata McGraw Hill.
3. Thomas Koshy: Elementary Number Theory with Applications, Academic Press, 2nd Edition.
4. Kenneth H. Rosen: Elementary Number Theory and its Applications, Addison-Wesley Publishing Company, 1986.
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs

**Suggested Readings (Part-B Relativity):**

1. D. F. Lawden: An Introduction to tensor calculus and relativity.
2. J. V. Narlikar: General relativity and cosmology.
3. R. H. Good: Basic concept of relativity, 1978.
4. A. S. Eddington: Mathematical theory of relativity, 1981.
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), BCA, B.Sc. (C.S.)

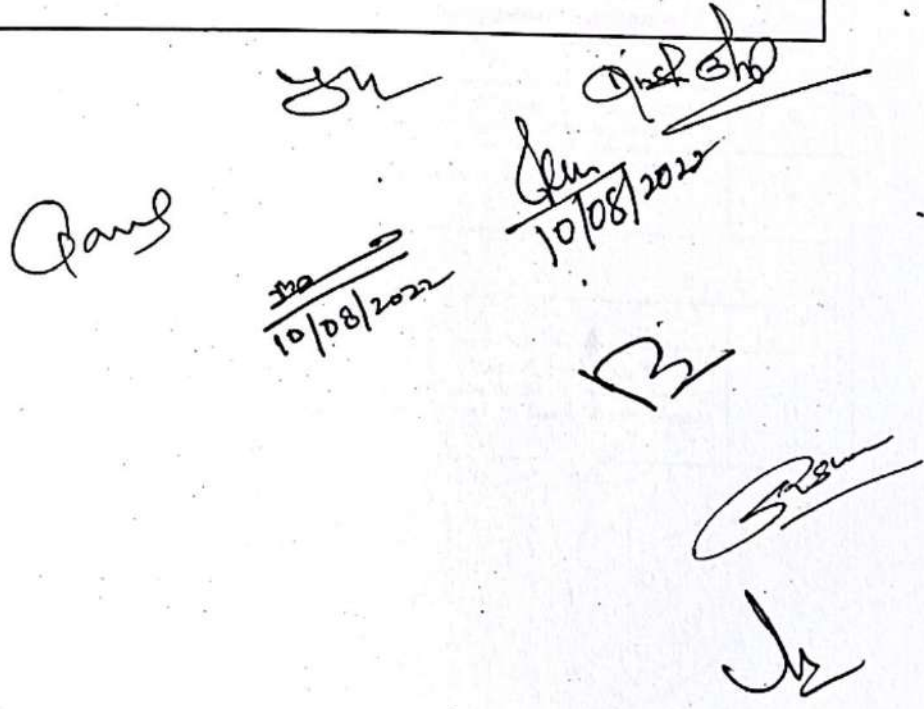
**Suggested Continuous Evaluation Methods: Max. Marks: 25**

S.No	Assessment Type	Max. Marks
1	Class Tests	10
2	Online Quizzes/Objective Tests	5
3	Presentation	5
4	Assignment	5

Course prerequisites: To study this course, a student must have Diploma in Mathematics.

Suggested equivalent online courses:

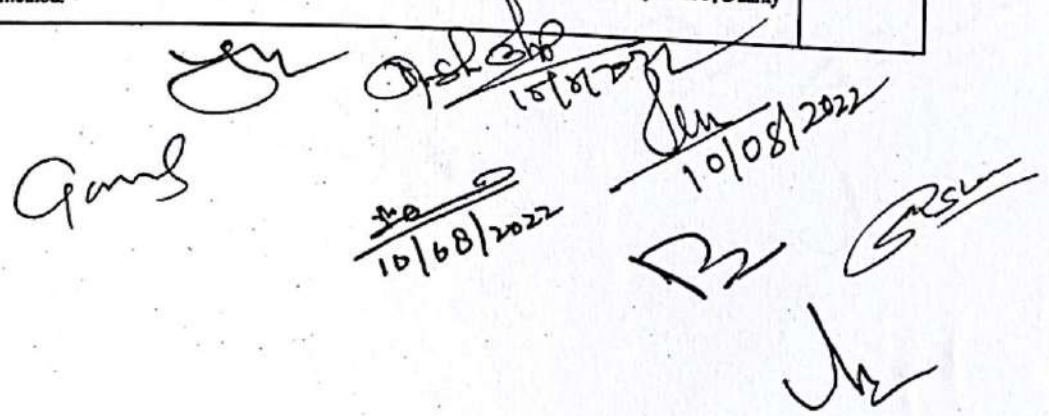
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**B.A./B.Sc. III (SEMESTER-V) PAPER-II (iii) Numerical Analysis and Operations Research**

Programme: Degree	Year: Third	Semester: Fifth
Class: B.A./B.Sc.	Subject: Mathematics	
Course Code: UGMATS02T	Course Title: Numerical Analysis and Operations Research	
Course outcomes:		
CO1: After Successful completion of this course the student will be able to perform error analysis for arithmetic operations.		
CO2: Upon successful completion, students will be able to understand the use of interpolation and curve fitting and finite differences.		
CO3: After Successful completion of this course students will be able to use some solution methods for solving the linear programming problems.		
Credits: 5	Core Compulsory / Elective	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0		
<b>PART-A</b>		
<b>Numerical Analysis</b>		
Unit	Topic	No. of Lectures
I	Errors in numerical Calculations: Absolute, Relative and Percentage errors, General Error, Error in series approximation.	9
II	Solutions of Algebraic and Transcendental Equations: Bisection method, False position method, Newton-Raphson Method, Picard's iteration method.	9
III	Linear systems of equations: Consistency of Linear System of equations, Solutions of Linear Systems by direct method: Guassian elimination and computation of inverse of a matrix, Method of Factorization, Solutions of linear systems by iterative methods: Jacobi method, Gauss-Siedel method.	10
IV	Interpolation and curve fitting: Errors in Polynomial interpolation, Finite differences, Differences of a polynomial, Newton's forward and backward interpolation, Central differences, Gauss, Stirling, Bessel's and Everett's Formulae, Lagrange's Interpolation formula.	10
V	Numerical differentiation and integration: Numerical differentiation, Newton-Cotes Integration formula, Numerical integration by Trapezoidal rule, Simpson's 1/3, Simpson's 3/8, and Romberg Integration.	9
<b>PART-B</b>		
<b>Operations Research</b>		
Unit	Topic	No. of Lectures
VI	Basics of OR and LPP: Development of OR, Definition, characteristics, scope, objectives and limitations of OR, convex sets, Basic feasible solutions, Formulation of LPP, Graphical Method to solve LPP, General LPP, Canonical and Standard forms, Properties of Solutions and Theory of Simplex method, Big M Method and Two phase simplex method, Degeneracy in LPP, Duality in LPP, Duality and simplex method, Dual simplex method.	16


  
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VII	Transportation and assignment Models: Formulation of TP, Transportation Table, Finding initial basic feasible solution, Test of optimality, Degeneracy, MODI method, Stepping Stone method, Solutions of Assignment problems, Hungarian method.	12
<p><b>Suggested Readings (Part-A Numerical Analysis):</b></p> <ol style="list-style-type: none"> <li>1. S. S. Sastry: Introductory Methods Numerical Analysis, Prentice- Hall of India.</li> <li>2. C.F. Gerald and P. O. Wheatley: Applied Numerical Analysis, Addison- Wesley, 1998.</li> <li>3. Korte and Debour: Numerical Analysis.</li> </ol> <p>4. Suggested digital platform: NPTEL/SWAYAM/MOOCs</p>		
<p><b>Suggested Readings (Part-B Operations Research):</b></p> <ol style="list-style-type: none"> <li>1. G. Hadley, Linear Programming, Narosa Publishing House, 1995.</li> <li>2. S. I. Gass, Linear Programming: Methods and Applications (4th edition) McGraw-Hill, New York, 1975.</li> <li>3. Kanti Swaroop, P.K. Gupta and Man Mohan, Operations Research, Sultan Chand &amp; Sons, New</li> <li>4. Hamdy A. Taha, Operations Research, Prentice-Hall of India, 1997.</li> </ol> <p>5. Suggested digital platform: NPTEL/SWAYAM/MOOCs</p> <p>This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), Economics(UG/PG), BBA/BCA, B.Sc.(C.S.)</p>		
<b>Suggested Continuous Evaluation Methods: Max. Marks: 25</b>		
S.No	Assessment Type	Max. Marks
1	Class Tests	10
2	Online Quizzes/Objective Tests	5
3	Presentation	5
4	Assignment	5
Course prerequisites: To study this course, a student must have Diploma in Mathematics.		
Suggested equivalent online courses:		
Further Suggestions:		

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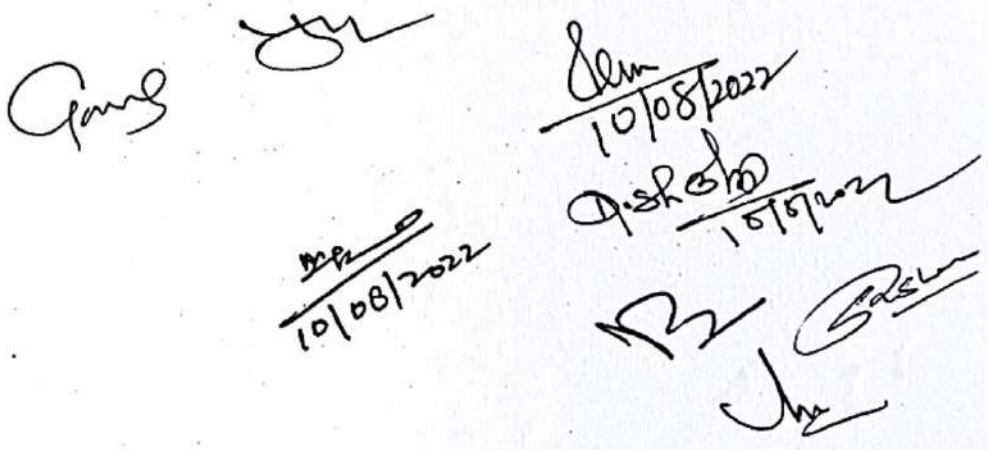
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## B.A./B.Sc. III (SEMESTER-VI) PAPER-I Complex Analysis and Mechanics

Programme: Degree Class: B.A./B.Sc.	Year: Third	Semester: Sixth
Course Code: UGMAT601T		Subject: Mathematics
Course Title: Complex Analysis and Mechanics		
<p><b>Course outcomes:</b></p> <p>CO1: 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.</p> <p>CO2: Upon successful completion, students will be able to understand the complex variables, analytic functions, complex integration and residues.</p> <p>CO3: The object of the paper is to give students knowledge of basic mechanics such as simple harmonic motion, motion under other laws and forces.</p> <p>CO4: The student, after completing the course can go for higher problems in mechanic such as hydrodynamics, this will be helpful in getting employment in industry.</p>		
Credits: 5	Core Compulsory / Elective	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0		
<b>PART-A</b>		
<b>Complex Analysis</b>		
Unit	Topic	No. of Lectures
I	<b>Complex Variables:</b> Functions of a complex variable, Limit, continuity and differentiability.	9
II	<b>Analytic functions:</b> Analytic functions, Cauchy and Riemann equations, Harmonic functions.	9
III	<b>Complex Integration:</b> Complex integrals, Cauchy's theorem, Cauchy's integral formula, Morera's Theorem, Liouville's Theorem, Taylor's series, Laurent's series, Poles and singularities.	10
IV	<b>Residues:</b> Residues, the Residue theorem, the principle part of a function, Evaluation of Improper real integrals.	9
<b>PART-B</b>		
<b>Mechanics</b>		
Unit	Topic	No. of Lectures
V	<b>Rectilinear motion:</b> Newton's Laws of Motion, velocity and acceleration, motion under constant acceleration, motion under inverse square law, rectilinear motion with variable acceleration, Simple Harmonic Motion.	10


  
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VI	Kinematics in two dimension: Angular velocity and angular acceleration, Components of velocity and acceleration along coordinate axes, Radial and transverse components of velocity and acceleration, tangential and normal components of velocity and acceleration.	10
VII	Motion in resisting medium, constrained motion and Central orbits: Terminal Velocity, Motion in resisting medium in a straight line, Motion on vertical circle, Cycloidal motion, Central Force, Central orbit, Intrinsic equation, Pedal form, apse and apsidal distance.	9
VIII	Statics: Coplanar Forces, Equilibrium of forces in three dimensions, Common catenary, Catenary of uniform strength, Virtual work.	9

**Suggested Readings (Part-A Complex Analysis):**

1. J. B. Conway: Functions of One Complex Variable, Narosa Publishing House, 1980.
2. E. T. Copson: Complex Variables, Oxford University Press.
3. L. V. Ahlfors: Complex Analysis, McGraw-Hill, 1977.
4. D. Sarason: Complex Function Theory, Hindustan Book Agency, Delhi, 1994..
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs

**Suggested Readings (Part-B Mechanics):**

1. M. Ray: A Textbook on Dynamics, S. Chand.
2. M. Ray: A Textbook on Statics, S. Chand.
3. A. S. Ramsay: Dynamics, Cambridge University Press.
4. S. L. Loney: Dynamics of a particle and of rigid bodies, Cambridge University Press.
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), B.Sc.(C.S.)

**Suggested Continuous Evaluation Methods: Max. Marks: 25**

S. No	Assessment Type	Max. Marks
1	Class Tests	10
2	Online Quizzes/Objective Tests	5
3	Presentation	5
4	Assignment	5

Course prerequisites: To study this course, a student must have Diploma in Mathematics.

Suggested equivalent online courses:

Further Suggestions:

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## B.A./B.Sc. III (SEMESTER-VI) PAPER-II Linear Algebra and Metric Spaces

Programme: Degree Class: B.A./B.Sc.	Year: Third	Semester: Sixth
Subject: Mathematics		
Course Code: UGMAT602T	Course Title: Linear Algebra and Metric Spaces	
<p>Course outcomes:</p> <p>CO1: 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.</p> <p>CO2: After Successful completion of this course, students should be able to understand the concept of linear transformation.</p> <p>CO3: On successful completion of the course students should have knowledge about metric spaces, connectedness and compactness.</p>		
Credits: 5	Core Compulsory / Elective	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0		
PART-A		
Linear Algebra		
Unit	Topic	No. of Lectures
I	Vector space: Introduction, subspaces, Linear combinations, linear spans, Sums and direct sums, Linear dependence and independence, Bases and dimensions, Dimensions and subspaces, Coordinates and change of bases.	10
II	Linear transformations: Linear transformations, rank and nullity, Linear operators, Algebra of linear transformations, Invertible linear transformations, isomorphism.	9
III	Matrix and linear transformation: Matrix of a linear transformation, Matrix of the sum and product of linear transformations, Change of basis, similarity of matrices.	9
IV	Linear functional: Linear functional, Dual space and dual basis, Double dual space, Annihilators, Hyperspace, Transpose of a linear transformation.	9
V	Eigen values and Eigen vectors: Eigen vectors and Eigen values of a matrix, product of characteristic roots of a matrix and basic results on characteristic roots, nature of the characteristic roots of Hermitian, skew-Hermitian, unitary and orthogonal matrices, characteristic equation of a matrix, Cayley-Hamilton theorem and its use in finding inverse of a matrix.	9
PART-B		
Metric Spaces		
Unit	Topic	No. of Lectures

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VI	Definition and examples of metric space, pseudo metric, discrete and usual metric space, diameter of a set	6
VII	Open and closed sets in a metric space, Interior point, Limit point, Adherent point, Closed set, Neighbourhood, Closure of a set, Interior of a set, Bolzano-Weirstrass theorem, Complete metric space, Cauchy sequence, Convergent sequence, Bounded Sequence	11
VIII	Separated sets, Connected and disconnected sets, Continuity and connectedness, Compactness, Compactness and uniform continuity, Continuity and Uniform continuity in a metric space.	12

**Suggested Readings (Part-A Linear Algebra):**

1. Hadley: Linear Algebra.
2. Hoffman and Kunze: Linear Algebra, Prentice Hall of India, New Delhi, 1972.
3. H. Helson: Linear Algebra, Hindustan Book Agency, New Delhi, 1994.
4. K. B. Dutta: Matrix and Linear Algebra, Prentice Hall of India.
5. S. Lang: Linear Algebra, Springer.
6. Suggested digital platform: NPTEL/SWAYAM/MOOCs.

**Suggested Readings (Part-B Metric Spaces):**

1. Dhananjay Gopal, An Introduction to Metric Spaces, Chapman and Hall/CRC, 1st edition 2020.
2. Satish Shirali & H. L. Vasudeva, Metric Spaces, Springer, First Indian Print. 2009
3. S. Kumaresan, Topology of Metric Spaces Narosa Publishing House, 2014
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs.

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), B.Sc.(C.S.)

**Suggested Continuous Evaluation Methods: Max. Marks: 25**

S. No	Assessment Type	Max. Marks
1	Class Tests	10
2	Online Quizzes/Objective Tests	5
3	Presentation	5
4	Assignment	5

Course prerequisites: To study this course, a student must have Diploma in Mathematics.

Suggested equivalent online courses:

Further Suggestions:

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## Minor/Additional/Interdisciplinary subject/Multidisciplinary First/Second Semester

Differential Calculus		
Unit	Topics	No. of Lectures
I	Functions of one variable, Limit of a function ( $\epsilon$ - $\delta$ Definition), Continuity of a function, Properties of continuous functions, Intermediate value theorem, Classification of discontinuities, Differentiability of a function, Jacobians, maxima and minima of single variable function, Rolle's Theorem, Mean value theorems and their geometrical interpretations, Applications of mean value theorems.	
II	Successive Differentiation, $n^{\text{th}}$ Differential coefficient of functions, Leibnitz Theorem, Taylor's Theorem, Maclaurin's Theorem, Taylor's and Maclaurin's series expansions.	
III	Geometrical meaning of tangent, Definition and equation of Tangent, Tangent at origin, Angle of intersection of two curves, Definition and equation of Normal, Cartesian sub tangent and subnormal, Tangents and normals of polar curves, Angle between radius vector and tangent, Perpendicular from pole to tangent, Pedal equation of curve, Polar sub tangent and polar subnormal, Derivatives of arc (Cartesian and polar formula).	
IV	Curvature, Radius of curvature, Cartesian, Polar and pedal formula for radius of curvature, Tangential polar form, Centre of curvature, Asymptotes of algebraic curves, Methods of finding asymptotes, Parallel asymptotes, existence and classification of singular points, points of inflection.	

### Suggested Readings

1. R. G. Bartle & D. R. Sherbert, Introduction to Real Analysis, John Wiley & Sons, 1999
2. T. M. Apostol, Calculus Vol. I, John Wiley & Sons Inc., 1974
3. Ajit Kumar and S. Kumaresan, A Basic Course in Real Analysis, CRC Press, 2019
4. S. Balachandra Rao & C. K. Shantha, Differential Calculus, New Age Publication, 1992
5. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc, 2007
6. G. B. Thomas and R. L. Finney, Calculus, Pearson Education, 2010
7. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Suggested Continuous Evaluation Methods: Max. Marks: 25

S.N.	Assessment Type	Max. Marks
1	Class Tests	
2	Online Quizzes/Objective Tests	10
3	Presentation	5
4	Assignment	5

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# Minor/Additional/Interdisciplinary subject/Multidisciplinary

## Third/Fourth Semester

### Analytical Geometry

Unit	Topics	No. of Lectures
I	Polar Equation of conics, Polar coordinate system, Distance between two points, Polar equation of a Straight line, Polar equation of a circle, Polar equation of a cone, Chords, Tangent and Normal to a cone	
II	Curvilinear coordinates, Spherical and Cylindrical coordinates, Definition and equation of a sphere, Plane section of a sphere, Intersection of two spheres, Intersection of a sphere and a line, Power of a point, tangent plane, Plane of contact, Polar plane, Pole, Angle of Intersection of two spheres, Radical plane, Co-axial system of spheres.	
III	Definition and equation of a cone, Vertex, Guiding curve, Generators, Three mutually perpendicular generators, Intersection of a line with a cone, Tangent line and tangent plane, Reciprocal cone, Right circular cone, Definition and equation of a cylinder, Right circular cylinder, Enveloping cylinder.	
IV	General equation of second degree, Tangent plane, Director sphere, Normal, Plane of contact, Polar plane, Conjugate plane and conjugate points	

#### Suggested Readings :

1. Robert J.T Bell, An Elementary Treatise on Coordinate Geometry of three dimensions, Macmillan India Ltd., 1923
2. P.R. Vittal, Analytical Geometry 2d & 3D, Pearson, 2013
3. S.L. Loney, The Elements of Coordinate Geometry, McMillan and Company, London. 2018
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs

#### Suggested Continuous Evaluation Methods: Max. Marks: 25

S.N.	Assessment Type	Max. Marks
1	Class Tests	
2	Online Quizzes/Objective Tests	10
3	Presentation	5
4	Assignment	5

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# Skill/Vocational Course-I

## First Semester

Matrices		
Unit	Topics	No. of Lectures
I	Matrix introduction, matrix operations with their properties, symmetric, skew-symmetric, Hermitian and skew-Hermitian matrices, idempotent, nilpotent, involutory, orthogonal and unitary matrices, singular and non-singular matrices, elementary operations on matrices, adjoint and inverse of a matrix, singular and non-singular matrices, negative integral powers of a non-singular matrix, Trace of a matrix.	
II	Rank of a matrix, elementary transformations of a matrix and invariance of rank through elementary transformations, normal form of a matrix, elementary matrices, rank of the sum and product of two matrices, inverse of a non-singular matrix through elementary row transformations, equivalence of matrices.	
III	Solutions of a system of linear equations, condition of consistency and nature of the general solution of a system of linear non-homogeneous equations.	

**Suggested Readings :**

1. Hari Kishan, A Textbook of Matrices, Atlantic Publishers, 2008
2. Fuzhen Zhang, Matrix Theory- Basic Results and Techniques, Springer, 1999
3. Shanti Narayan, P.K. Mittal, A Textbook of Matrices, S Chand & Company, 2010
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs

**Suggested Continuous Evaluation Methods: Max. Marks: 25**

S.N.	Assessment Type	Max. Marks
1	Class Tests	10
2	Online Quizzes/Objective Tests	5
3	Presentation	5
4	Assignment	5

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# Skill/Vocational Course-I

## Second Semester

PART-A		
Integral Calculus		
Unit	Topics	No of Lectures
I	Integral as a limit of sum, Properties of Definite integrals, Fundamental theorem of integral calculus, Summation of series by integration, Infinite integrals, Differentiation and integration under the integral sign.	
II	Beta function, Properties and various forms, Gamma function, Recurrence formula and other relations, Relation between Beta and Gamma function, Evaluation of integrals using Beta and Gamma functions.	
III	Double integrals, Repeated integrals, Evaluation of Double integrals, Double integral in polar coordinates, Change of variables, Change of order of integration in Double integrals, Triple integrals, Evaluation of Triple integrals, Drichlet's theorem and its Liovelle's extension.	
IV	Area bounded by curves (quadrature), Rectification (length of curves), Volumes and Surfaces of Solids of revolution.	

**Suggested Readings :**

1. T.M. Apostol, Calculus Vol. 1, John Wiley & Sons Inc., 1974
2. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc, 2007
3. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2010
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs

**Suggested Continuous Evaluation Methods: Max. Marks: 25**

S.N.	Assessment Type	Max. Marks
1	Class Tests	10
2	Online Quizzes/ Objective Tests	5
3	Presentation	5
4	Assignment	5

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# Skill/Vocational Course-I

## Third Semester

Part-A		
Group Theory		
Unit	Topics	No. of Lectures
I	Cartesian product of Sets, Functions or mappings, Binary operations, Relation, Equivalence relations and partitions, Congruence Modulo n, Definition of a group with examples and simple properties, Abelian group, Finite and infinite group, Order of a finite group, General properties of groups, Composition table for finite groups	
II	An Alternative set of postulates of groups, Subgroups, Permutations, Cyclic Permutations, Even and odd permutations, group of Permutations alternating group, Integral power of an element of a group, Order of an element of a group, Group homomorphism, Isomorphism on groups, the relation of isomorphism in the set of all groups Complexes and subgroup of a group, theorems on subgroups, Coset decomposition, Lagrange's theorem and its consequences, Cayley's theorem, Cyclic group, generating system of group	
III	Normal subgroups, Simple group, Conjugate elements, Normalizer of an element of a group, Class equation of a group, Centre of a group, Conjugate subgroups, Invariant sub groups, Quotient group, Homomorphism and Isomorphism on groups, Kernel of a Homomorphism and related theorems.	

**Suggested Readings :**

1. J. B. Fraleigh, A first course in Abstract Algebra, Addison-wiley, 2003
2. I. N. Herstein, Topics in Algebra, John Wiley & Sons, 2006
3. Thomas W Hungerford, Abstract Algebra—An Introduction, Saunders College Publishing, 1990
4. Joseph A Gallian, Contemporary Abstract Algebra, Brooks/Cole Cengage Learning, 2016
5. V. K. Khanna and S. K. Bhambri, A course in Abstract Algebra, Vikas Publishing House Pvt (Ltd), 2014.
6. Suggested digital platform: NPTEL/SWAYAM/MOOCs

**Suggested Continuous Evaluation Methods: Max. Marks: 25**

S.N.	Assessment Type	Max. Marks
1	Class Tests	
2	Online Quizzes/Objective Tests	10
3	Presentation	5
4	Assignment	5

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## Skill/Vocational Course-I Fourth Semester

Ordinary Differential Equations		
Unit	Topics	No. of Lectures
I	Introduction of Differential equations, Order and Degree of Differential Equations, Complete primitive (general solution, particular solution and singular solutions), Existence and uniqueness of the solution $dy/dx = f(x,y)$ .	
II	Differential equations of first order and first degree, Separation of variables, Homogeneous linear Equations, Exact Equations, Integrating Factor, Linear Equation, Equation of First order but not of first degree, Various methods of solution, Clairaut's form, Singular solutions. Trajectory, Orthogonal Trajectory, Self-Orthogonal family of Curves.	
III	Linear differential equations with constant coefficients, Complementary function, Particular integral, Working rule for finding solution of linear differential equations with constant coefficients, Homogeneous linear equations or Cauchy-Euler equations.	
IV	Simultaneous differential equations, Differential equations of the form $dx/P = dy/Q = dz/R$ where P, Q, R are functions of x, y, z. Exact differential equations, Total differential equations, Series solutions of differential equations, Linear differential equations of second order with variable coefficients, Initial and boundary value problems.	

**Suggested Readings:**

1. G.F. Simmons, Differential Equations with Application and Historical Notes, Tata-McGraw Hill, 2002
2. B. Rai, D.P. Choudhary & H. J. Freedman, A Course of Ordinary Differential Equations, Narosa, 2002
3. Ian N. Snedden, Elements of Partial Differential Equations, Dover Publication, 2013
4. L.E. Elsgolts, Differential Equation and Calculus of variations, University Press of the Pacific. 1970
5. M. D. Raisinghania, Ordinary and Partial Differential Equations, S Chand, 2018.
6. Suggested digital platform: NPTEL/SWAYAM/MOOCs

**Suggested Continuous Evaluation Methods: Max. Marks:25**

S.N.	Assessment Type	Max. Marks
1	Class Tests	
2	Online Quizzes/Objective Tests	10
3	Presentation	5
4	Assignment	5

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# **National Education Policy - 2020**

**Sri Dev Suman Uttarakhand University, Badshahithaul,  
New Tehri**



**Syllabus**

**for**

**Sri Dev Suman Uttarakhand University Campus and Affiliated  
Colleges**

**Department of Zoology**

**Pt. LSM Sri Dev Suman Uttarakhand University, Campus  
Rishikesh**

**BOS held on August 10, 2022**



## Preamble

The objective of any program at Higher Education Institute is to prepare their students for the society at large. The Sri Dev Suman Uttarakhand University, Badshathaul, New Tehri is to prepare their students for sustainability and lifelong learning. It envisions its entire program in the best interest of their students and in this endeavor provides a focused, outcome based syllabus at the graduate and post graduate levels.

Renewing and updating of the curriculum is the essential, continuous and perpetual exercise of any vibrant Academic System. The department of zoology offers update and pertinent teaching programme with emphasis on fundamentals as well as emerging areas of modern biology. Courses within zoology are upgraded keeping in mind the aspirations of the students, changing nature of the subject as well as to maintain the standard of Zoology degree programme across the country.


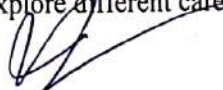

## Introduction

Zoology is one of the most fundamental branches of biology studied at undergraduate level. Zoology is a broad subject encompassing classical and modern systemic aspect of animal diversity as well as contemporary subjects like molecular biology, bioinformatics, biotechnology etc. The scope of zoology as a subject is wide-ranging. The major areas of study within the discipline of zoology are: Diversity of Non-chordates and chordates; Comparative Anatomy of Vertebrates; Cell Biology; Developmental biology; Biochemistry; Molecular Biology; Evolutionary Biology; Principle of Genetics; Principles of Ecology and Physiology etc. Degree course in Zoology deals with other topics that overlap with the area mentioned above (Immunology; Parasitology; Basics of Neurosciences; Animal Behaviour and Chronobiology; Animal Biotechnology; Biology of insects; Endocrinology; Computational Biology; Fish and Fisheries; Reproductive Biology and Wildlife Conservation and Management) and that address the topics related to applied fields (such as Apiculture; Aquarium Fish Keeping; Med Diagnostics; Research Methodology and Sericulture).

This will provide them ample opportunities to explore different career avenues. The course has been designed to provide in-depth knowledge of applied subjects to develop various skills to make a career and become an entrepreneur in the field of aquatic biology, sericulture, apiculture etc. After completion of this course students will be able to contribute as policy makers in wild life conservation animal preservation and environment protection.

## Aim of Bachelor Degree Programme

The aim of zoology degree programme is to provide platform to learn and understand the concepts regarding animal diversity to appreciate the variability in relation to their morphology, anatomy and behaviour among different animals. After studying this course our students will be equipped to learn and know about different human systems, their coordination and control. This course will also provide an opportunity to understand their own evolution along with other animals. They will be able to qualitatively and quantitatively analyse evolutionary parameters using various bioinformatics and computational tools used in modern sciences. This will provide them ample opportunities to explore different career avenues.

  
  
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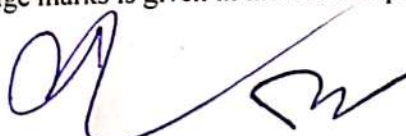



applied subjects ensuring the inculcation of employment skills so that students can make a career and become an entrepreneur in diverse field of aquatic biology, sericulture, apiculture etc. After completion of this course students can contribute as policy makers in wild life conservation animal preservation and environment protection.

### Introduction to Choice Based Credit System (CBCS):

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enable the potential employers in assessing the performance of the candidates.

#### Definitions:

- (i) 'Academic Programme' means an entire course of study comprising its programme structure, course details, evaluation schemes etc. designed to be taught and evaluated in a teaching Department/Centre or jointly under more than one such Department/ Centre
- (ii) 'Course' means a segment of a subject that is part of an Academic Programme
- (iii) 'Programme Structure' means a list of courses (Core, Elective, Open Elective) that makes up an academic programme, specifying the syllabus, credits, hours of teaching, evaluation and examination schemes, minimum number of credits required for successful completion of the programme etc. prepared in conformity to University rules, eligibility criteria for admission
- (iv) 'Core Course' means a course that a student admitted to a particular programme must successfully complete to receive the degree and which cannot be substituted by any other course
- (v) 'Elective Course' means an optional course to be selected by a student out of such courses offered in the same or any other Department/Centre
- (vii) 'Credit' means the value assigned to a course which indicates the level of instruction; One-hour lecture per week equals 1 credit, 2 hours practical class per week equals 1 credit. Credit for a practical could be proposed as part of a course or as a separate practical course
- (viii) 'SGPA' means Semester Grade Point Average calculated for individual semester.
- (ix) 'CGPA' is Cumulative Grade Points Average calculated for all courses completed by the students at any point of time. CGPA is calculated each year for both the semesters clubbed together.
- (x) 'Grand CGPA' is calculated in the last year of the course by clubbing together of CGPA of two years, i.e., four semesters. Grand CGPA is being given in Transcript form. To benefit the student a formula for conversation of Grand CGPA into %age marks is given in the Transcript.

  
  
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## Theory and Practical Examination Pattern

Theory (External) each theory paper carrying maximum marks 75 and shall consist of <sup>three</sup> ~~two~~ sections A, B and C. Examination duration shall be 02 hours.

- a. Section A: Multiple choice questions (MCQ)/true and false/very very short answer type questions.  
Section A will consist of 10 questions, each of one mark)  
**Total: 10X1= 10 Marks**
- b. Section B: (Short answers type , 200 words)  
Section B will consist of 08 questions, each of 7 marks in which 5 has to be answered.  
**Total: 7X5= 35 Marks**
- c. Section C: (Long answers type, 500 words)  
Section C will consist of 3 long answered questions, in which has to be answered, each of 15 marks.  
**Total: 2X15= 30 marks**

For each theory paper internal assessment shall be conducted periodically (in the form of class tests and/or assignments/ group discussion/ oral presentation/ overall performance) during the semester period. Total marks allotted to internal assessment shall be 25 (Assignments 10 marks, written test/viva 10 marks and regularity 5 marks). The evaluated answer sheets/assignments have to be retained by the Professor In-Charge for the period of six months and can be shown to the students if students want to see the evaluated answer sheets. The marks obtained by the students shall be submitted to the Head of concerned department/ the Principal of the College for uploading onto the University examination portal.

**Practical** The laboratory work of the students has to be evaluated periodically.

The internal assessment (in the form of lab test, lab record, internal evaluation, assignment/home assignment and attendance) of total 10 marks for each semester shall be conducted during the semester. All kinds of exercises have to be conducted during a semester. Maximum 5 marks of attendance can be given to the students.

In each semester practical examination of 40 marks has to be conducted by two examiners (External and internal) having duration of 4 hours. The total number of students to be examined per batch should not be more than sixty. Marks obtained in the practical examination have to be submitted to the Head of the department/ Principal of the College. The Head of the Department/Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, Sri Dev Suman Uttarakhand University, Badshahithaul, New Tehri.

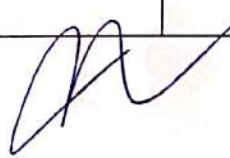


The breakup of marks for practical examination for each semester would be as follows:

Practical exam:	30 Marks (exercises)
Viva voce:	05 Marks
Lab Record and collection:	05 Marks
Sessional (Internal):	10 Marks
Total:	50 marks (each semester)

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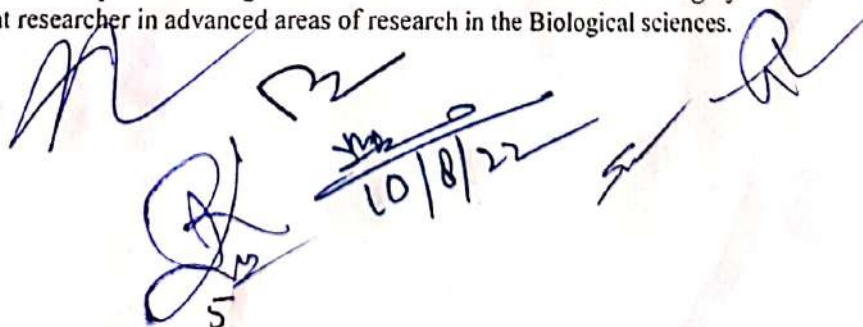
YEAR	SEMESTER	PAPER CODE	PAPERTITLE	CREDITS TH+PR
<b>Certificate course in Clinical Diagnostics &amp; Biochemistry</b>				
1	I	ZOO101T	Animal Physiology and Biochemistry	4+2
	II	ZOO201T	Genetics and Cell Biology	4+2
	I&II	Minor Elective	Environmental science and Basic concepts of Ecology	4+2
<b>Diploma in Molecular Sciences &amp; Clinical Microbiology</b>				
2	III	ZOO301T	Molecular Biology, Toxicology & Histology	4+2
	IV	ZOO401T	Microbiology and Animal Behaviour	4+2
	III & IV	Minor Elective	Bio-Instrumentation, Bioinformatics and Biostatistics	4+2
<b>Degree in Bachelor of Zoology</b>				
3	V	ZOO501T	Non-Chordate	4+1
		ZOO503T	Chordate	4+1
		Industrial Training/Survey/Research Project	It is based on Major Papers of Semester-V	04
	VI	ZOO601T	Developmental Biology of Vertebrates	4+1
		ZOO603T	Basic mammalian Endocrinology	4+1
		Industrial Training/Survey/Research Project	With reference to Major Papers of Semester-VI	04
<b>Bachelor (Research) in Faculty</b>				
4	VII	PAPER- I	Fundamentals of Immunology	4+1
		PAPER- II	Applied Immunology	4+1
		PAPER- III	Animal Ecology	4+1
		PAPER- IV	Medical Laboratory Techniques	4+1
		Industrial Training/Survey/Research Project	With reference to Major Papers of Semester-VII	04
	VIII	PAPER- I	General Ichthyology	4+1
		PAPER- II	Applied Ichthyology	4+1
		PAPER- III	Basic Limnology	4+1
		PAPER- IV	Animal Ecology	4+1
		Industrial Training/Survey/Research Project	With reference to Major Papers of Semester-VIII	04
VII or VIII	Minor Elective	Chronobiology or Applied Zoology or General Biotechnology	4+1	


  
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<i>Master in Faculty (Zoology)</i>				
5	IX	PAPER- I	Systematics And Applied Entomology	4+1
		PAPER- II	Biology Of Insects (Morphology, Physiology & Development )	4+1
		PAPER- III	Economic Zoology And Vermicology	4+1
		PAPER- IV	Wildlife Conservation	4+1
		Industrial Training/Survey/ Research Project	With reference to Major Papers of Semester-IX	04
	X	PAPER- I	Animal Biotechnology	4+1
		PAPER- II	(Animal Cell Culture)+	4+1
		PAPER- III	Animal Biotechnology (Transgenics, Cloning And IPR)	4+1
		PAPER- IV	Medical Laboratory Techniques Wildlife Conservation	4+1
		Industrial Training/Survey/ Research Project	With reference to Major Papers of Semester-X	04

### Course Objective (CO):

- The programme in Zoology aims to equip students with recent advances in Zoology from organismic to reductionist biology.
- It also aims to empower students to understand the challenges of society and the country that falls into the realms of Zoology, such as Aquaculture, Reproductive health, Behavior and Biological time keeping, Cancer Biology, Microbiome and their roles in health and diseases, Bioremediation of pollutants and pesticides, etc.
- It also offers students to a series of elective courses so that they can choose to specialize in the specific area of their interests in Zoology.
- The open elective has been chosen to attract students from diverse interdisciplinary areas of sciences, such as Anthropology, Environmental studies, Biomedical Sciences, etc.
- This course is designed to ignite the inquisitive mind to enter in to research in interdisciplinary areas. The fourth semester offers a total of 16 elective courses, which for logistics of programme management, are divided in to four streams, where a student has to choose a stream.
- In the entire course, the major emphasis is on skill-based training into socially relevant areas of Zoology.
- It is expected that a student after successfully completing the programme would sufficiently be skilled and empowered to solve the problems in the realms of Zoology and its allied areas.
- They would have plethora of job opportunities in the education, environment, agriculture-based, and health related sectors.
- The bright and ignited mind may enter into research in the contemporary areas of Zoological/Biological Sciences.
- The broad skills and the deeper knowledge in the field would make them highly successful and excellent researcher in advanced areas of research in the Biological sciences.


  
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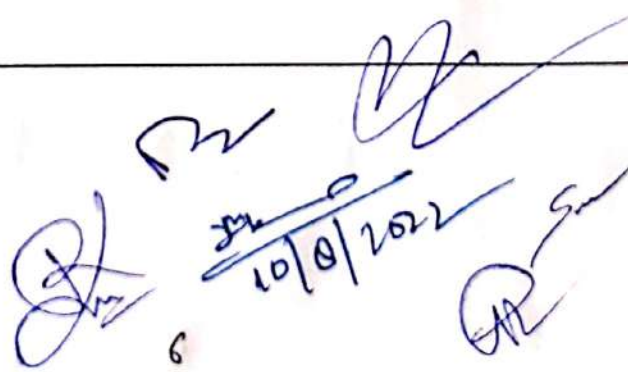


**Programme Objective (POs):**




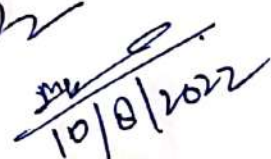


PO 1	It will enhance the basic knowledge about the different systems of an organism and the clinical study of biomolecules.
PO 2	It will help students to pursue the initial fundamentals required for future projects and higher studies.
PO 3	It will help to inculcate the evolutionary basis of various animals and their development. It will also address the present situation of animal diversity.
PO 4	It will help students to identify the concepts about various Applied sciences and Medical laboratory techniques related to concerned area.
PO 5	It will help to develop the knowledge on taxonomy of insects. Also, the conservation of wild animals to enhance the economy gained by the zoological content present in the environment.
PO 6	All the above POs will lead to a mind that can develop modern technologies to address the problems and to give solution to it.

**Programme Specific Objective (PSO):**

<b><i>CERTIFICATE COURSE IN CLINICAL DIAGNOSTICS &amp; BIOCHEMISTRY</i></b>	
YEAR 1	This will help students to generate employment in the field of clinical & medical lab/institutions/gene bank/stem cell culture/Pharma companies etc.
<b><i>DIPLOMA IN MOLECULAR SCIENCES &amp; CLINICAL MICROBIOLOGY</i></b>	
YEAR 2	This will help students to develop the scientific ability in the field of toxicological, Histological, Microbiological, Molecular labs, various Zoological Parks, National Parks, Wildlife Sanctuaries.
<b><i>BACHELOR OF SCIENCE (ZOOLOGY)</i></b>	
YEAR 3	This will help students to develop the basis of Animal diversity and its development, which can generate various academic/Research jobs and various other jobs in the field of In-vitro labs, case study of endocrinology in medical labs etc.

  
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<i>BACHELOR (RESEARCH) IN FACULTY</i>	
<b>YEAR</b> 4	It will help students to pursue career in various health related departments and medical laboratories. It is beneficial for students as they can work in different Chrono-centre as per demands for biological clock management to travel across continents (both public and private sector).
<i>MASTER IN FACULTY (ZOOLOGY)</i>	
<b>YEAR</b> 5	It will help students to improve the Agro-Pest relationship, forensic Entomology & its implication it help to conserve the environment & Ecology. Also at the same time students will be equipped to explore jobs in Zoological Research i.e. CTB, CSB, ZSI, WII etc.

# Syllabus

## First Year

### Semester- I

#### Animal Physiology and Biochemistry (4+2 Credits) = 6 Credits

##### Animal Physiology

Nutrition: Food constituents, intracellular and extracellular digestion, Digestion and absorption of carbohydrate, fat and protein.

Respiration: Pulmonary ventilation, respiratory pigments, gaseous transport and control of respiration. With reference to dissociation of oxyhaemoglobin.

Excretion: Concept of ammonotelic, ureotelic and guanotelic animals, urine formation in mammals.

Blood vascular system: Haemopoiesis, composition and functions of blood, blood coagulation. A brief account of immunity. Types of heart, origin and conduction of heart beat. Cardiac Cycle

Nervous system: Types of Neurons Resting and action potential of nerves, synapse and transmission of nerve impulse. Neurotransmitter

Muscular system: Types of Muscles molecular and chemical basic of Muscle contraction and its Mechanism. A brief idea of tetanus and fatigue.

##### Biochemistry

Introduction to biological molecules: Proteins, Amino acids, Carbohydrates and Lipids- their structure, classification and significance. Metabolism of Carbohydrates. Enzymes and Vitamins.

(glycolysis, Krebs cycle, gluconeogenesis , glycogenesis glyogenolysis)

Mechanism of Enzyme Action, Kinetics , Inhibition & Regulation Vitamins, Types & source, deficiencies.

##### Practical

##### Suggested books:

1. Ganong: Review of Medical Physiology, Lang Medical Publ.
2. Guyton and Hall; Textbook of Medical Physiology WB Saunders.
3. Keel et al: Sampson Wright's Applied Physiology, Oxford Press.
4. C.C. Chatterjee: Human Physiology.
5. Nielson: Animal Physiology, Cambridge.
6. Jain A.K.: Textbook of Physiology, Avical Publishing Company.
7. Conn And Stumpf: Outlines of Biochemistry, John Wiley.

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## Semester- II

### Genetics and Cell Biology (4+2 Credits) = 6 Credits

#### Genetics

Mendel's life, Pre-Mendelian experiments, symbols and terminologies, Laws of dominance, segregation and independent assortment.

Linkage: Coupling and repulsion hypothesis, Morgan's view of linkage, kinds of linkage, chromosome theory of linkage.

Crossing over: Somatic and germinal crossing over, kinds of crossing over, theories of the mechanism of crossing over, significance.

Eukaryotic chromosomes- Structure, chemical composition, classification and unigenic and multigenic concept of chromosome structure.

Structure and functions of polytene and lampbrush chromosomes.

Determination of sex: chromosome mechanism, Genic balance theory, External environment and sex determination.

Sex linked inheritance: Inheritance of X-linked gene (Colour blindness and haemophilia in man), Sex linkage in Drosophila.

Mutation: Historical background, chromosomal mutation (Chromosomal aberrations), gene mutations and their interpretation.

#### Cell Biology

Prokaryotic and Eukaryotic cells; Ultrastructure of eukaryotic cell; Plasma membrane (Ultrastructure, chemical composition, models of plasma membrane; Specialisations of plasma membrane, functions of plasma membrane).

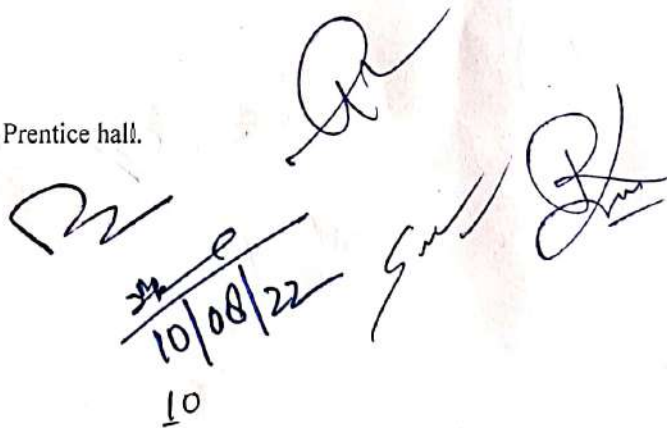
Structure and functions of following cell organelles: (a) Mitochondria (b) Ribosomes (c) Lysosomes (d) Centrioles (e) Golgi Complex (f) Endoplasmic reticulum. Structure and functions of Nucleus and nucleolus.

Cell division – (a) Cell cycle (b) Mitosis (Process of mitosis, mitotic poisons and significance of mitosis), (c) Meiosis (Process of meiosis, structure and functions of synaptonemal complex, significance of meiosis). An idea of cell transformation and cancer.

#### Practical

#### Suggested books:

1. Strickberger: Genetics, Prentice hall.

  
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2. Principles of Genetics, Snustad and Simmons, John Wiley & Sons, USA.
3. Modern Genetics Analysis: Integrating Genes and Genomes, Griffith, J.F., Gelbart, M., Lewontin, C and Miller, W.H. Freeman and Company, New York, USA.
4. Genetics, J Russell, Benjamin- Cummings Publishing Company, San Francisco, California, USA.
5. Lodish-et al, Molecular Biology
6. P.K. GUPTA, Cell Biology and Genetics.

## Minor/Elective

### Environmental science and Basic Concepts of Ecology

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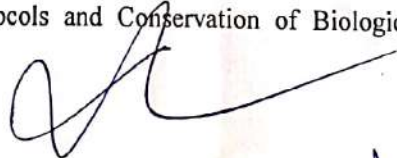
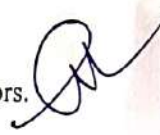




#### Environmental science

1. Introduction of environmental Science: Definition, principles and scope of environmental science, structure and composition of atmosphere, hydrosphere, lithosphere and biosphere.
2. Ecosystems: definition, structure and function of ecosystem, energy flow in an ecosystem, food chain, food web and ecological, case studies of the following ecosystem: forest ecosystem, grassland ecosystem, desert ecosystem and aquatic ecosystem.
3. Natural resources: Renewable and Non-renewable resources: land resources and land use change, land degradation soil erosion and desertification. Deforestation: causes and impacts due to mining, dam building on environment, of surface and ground water, floods, droughts, conflicts over water (international & inter-state). Energy resources: Renewable and non-renewable energy sources, growing energy needs case studies.
4. Biodiversity and conservation: Level of biodiversity- genetic, species and ecosystem diversity, Bio geographic zones of India, biodiversity patterns and global biodiversity hotspots. India as a mega-biodiversity nation, endangered and endemic species of India. Threats to biodiversity - Habitat loss, poaching of wildlife, man-wildlife conflict, biological invasions, conservation of biodiversity-in-situ ex-situ conservation of biodiversity.
5. Environmental Pollution: Types, causes, effects and controls, air, water, soil and noise pollution. Nuclear hazards and human health risks. Solid waste management-Control measures of urban and industrial waste. Pollution case studies.
6. Environmental Policies & Practices: Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture. Environmental laws- Environmental Protection Act- Air (Prevention & Control of Pollution) Act. Water (Prevention & Control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, International agreements-Montreal and Kyoto protocols and Conservation of Biological Diversity (CBD).

#### Basic Concepts of Ecology

Definition of ecology and its relation to humanity.

The environment: Abiotic factors, biotic factors, edaphic factors.



Concept of ecosystem with reference to pond, Grassland, Forest & River ecosystem. Energy flow in ecosystem. Pyramids of number, biomass and energy. Food chain- grazing and detritus, Food web and trophic levels. Biosphere: Hydrosphere, Lithosphere and Atmosphere.

Biogeochemical cycles: Carbon and Nitrogen cycles.

Population: Definition and characteristics: density, natality, mortality, migration, emigration and immigration, growth and growth-curves. Dispersion and aggregation. Negative and positive interactions including commensalism, mutualism, predation, competition and parasitism.

### Practical

### Suggested books:

1. Odum, E.P: Fundamental of Ecology, Saunders Co. Publ. Indian Ed.
2. Chapman & Reiss: Ecology.
3. Smith, R.L: Ecology & Field Biology.
4. Singh & Kumar: Ecology and Environmental Science, Vishal Publ.
5. Odum, E.P: Fundamental of Ecology, Saunders Co. Publ. Indian Ed.
6. Ecology and Environment by P.D. Sharma.

## Second Year

### Semester- III

#### Molecular Biology, Toxicology & Histology

(4+2 Credits) = 6 Credits

#### Molecular Biology

Nucleic acids (DNA & RNA): DNA chemistry, nucleosides, nucleotides, polynucleotide chain, Watson and Crick DNA double helix model, identification of genetic material (DNA-as genetic material). RNA-chemistry, genetic and non-genetic RNAs. Clare leaf model of RNA Elementary knowledge of genetic code. Expression of gene-protein synthesis.

Lac operon concept. Mechanism of DNA damage & repair

#### Toxicology

Introduction and brief history of toxicology: General principles of toxicology, Brief history, Environmental toxicology (kinds and sources of toxic agents- animal toxins, plant toxins, pesticides, metals and food additives).

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Dose response relationship: Frequency and cumulative responses, determination of TLM values,  $LC_{50}$ , margin of safety, threshold limits.

## Histology

Histology: Structure of epithelium, connective tissue, cartilage, bone, smooth,, striped and cardiac muscles, and nervous tissue as studied under light microscope.

Histological structure of gonads, liver, lung, pancreas and kidney in mammals.

## Practical

### Suggested books:

1. Molecular Cell Biology, Lodish et al., W.H. Freeman and Company, New York, USA.
2. Molecular Biology of the Cell, Alberts et al., Garland Science, Taylor and Francis Group, New York, USA.
3. De- Robertis- Cell and Molecular Biology.
4. Verma, P.S. and Agrawal, V.K. Molecular Biology
5. Tortora- Microbiology and Introduction.
6. Parija- Textbook of Microbiology.
7. Pelczar: Microbiology, Tata McGraw Hill.
8. Davis: Microbiology Harper & Row, Publ. Inc.
9. Textbook of Toxicology By Bafram Pani.
10. "Casarett & Doull's Essentials of Toxicology", 2nd Ed. Edited by Curtis A. Klaassen & John B. Watkins III, published by McGraw Hill-Lange
11. "Handbook of Toxicology", M.J.Derelanko & C.S.Auletta, 3rd Ed. CRC Press
12. Principles of Biochemical Toxicology" by J.A.Timbrell

## Semester- IV

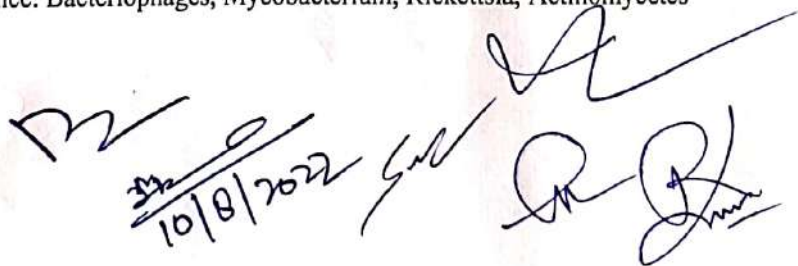
### Microbiology and Animal Behaviour (4+2 Credits) = 6 Credits

#### Microbiology

Introduction to microbiology: kinds of microbes, Typical structure of a bacterium, Gram positive and Gram negative bacteria and virus. With reference to (COVID)

Microbes of medical importance: Bacteriophages, Mycobacterium, Rickettsia, Actinomycetes and Mycoplasma.

A brief knowledge of AIDS.

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Environmental use of microorganisms: Nutrient cycle, Metal recovery, petroleum recovery, pest control, waste water treatment and Bioremediation.

Industrial microbiology- Food production, dairy products, fermented food, alcoholic beverages, microbial spoilage, food preservation. A brief knowledge of Antibiotics.

### **Animal Behaviour**

*Patterns of behaviour:* Stereotype innate behaviour: Kinases, Taxes and Reflexes. Concepts of (i) Fixed action patterns (ii) Sign or key stimulus or releasers and (iii) Innate releasing mechanism, Instinctive behaviour. Learned behaviour: Habituation, Conditioned reflexes, Selective learning, Insight learning, Imprinting, Song learning in birds. Hormonal control of Behaviour

Communication: Chemical, Visual, Auditory, Electric and tactile, Dance language of honey bees, Biological clocks. Bird migration with particular reference to the mechanisms of navigation. Introduction to Socio-biology: Social structure in primates

### **Practical**

#### **Suggested books:**

1. Mechanism of Animal Behaviour Peter Marlar & J. Hamilton.
2. Animal Behaviour by David McFarland.
3. Animal Behaviour John Alcock.
4. Pelczar Microbiology
5. Davies Microbiology

## **Minor/Elective BioInstrumentation, Bio Informatics and Biostatistics**

**(4+2 Credits)**

### **BioInstrumentation**

Principles and Techniques of Microscopy; Magnification and Resolution Parameters of Light, Fluorescent Phase Contrast Scanning, Transmission Electron Microscopy, Tunneling Microscopy and Inverted Microscope, Micrometry, Colony Counting and Microtomy. Laboratory Safety Guidelines.

Centrifugation – Basic Principles of Sedimentation, Types of Centrifuges, Ultracentrifugation, Differential and Rate Zonal Separations, Organellar Separation and Flow Cytometry.

Principle & Applications of Ph Meter, Spectroscopy UV- Vis, Mass Spectrometry (MS) and X-Ray Crystallography.

*Dr. S. S. S. S.*  
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Chromatographic Techniques, Paper Chromatography, Partition Chromatography, Column Chromatography, Thin Layer Chromatography, Gas Chromatography, Ion Exchange, Affinity Chromatography and Introduction to HPLC,

Electrophoresis: Capillary, Agarose, SDS & Native PAGE, Pulse Field, Immuno-Electrophoresis and Paper Electrophoresis.

PCR & Thermal Cyclers, Nucleic Acid Hybridization: Southern & Northern Blotting, Western Blotting, Autoradiography. ELISA and RIA.

## Bio Informatics

Introduction to Computers, Computer Fundamentals (Hardware & Software), Input, Output Devices and Storage Devices, Web Browsers, Search Engines, Flow Charts, Methods and Types of Networks, Intra and Internet, Introduction to MS-Office.

Introduction to Bioinformatics, Scope and Application of Bioinformatics, NCBI Data Model, DNA and Protein Sequence Database, Motif Analysis, Structural Database, Structural Viewers (Rasmol, Rastop, Cn3D, CSHF Chimera, Swiss PDB Viewer, Pymol), Sequence Submission to Database, Literature Database (Pubmed, Biomed Central, Medline), Internet and Biologist. Online Study *E. coli*, *D. melanogaster*, Human Genome, Mice Genome. DNA Chips and their Replications.

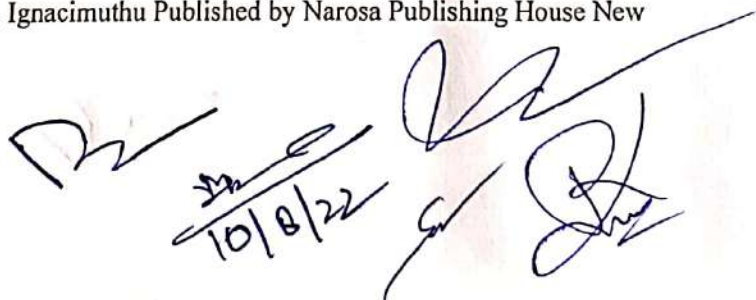
## Biostatistics

Introduction to Biostatistics, Terminology and Symbols, Research and Types of Research, Applications of Statistics in Biological Research, Data, Collection and Representation of Data (Pie Chart, Bar Diagram, Histogram, Frequency Polygon and Gantt Chart), Measures of Central Tendency (Mean, Median, Mode), Variance, Coefficient of Variation, Standard Deviation, Standard Error of Mean, Analysis of Variation (ANOVA), One Way ANOVA and Two Way ANOVA. Measures of Dispersion, Distribution Patterns (Binomial, Poisson & Normal), Tests of Significance ('T' Test, 'F' Test & Chi-Square Test), Probability, Correlation and Regression Analysis, Introduction to Statistical Software and Handling (SPSS And Excel Data Sheets).

## Practical

### Suggested books:

1. Introduction to Biostatistics by Dr. Pranab Kr. Banarjee.
2. Bioinstrumentation by L. Veerakumari
3. Bioinformatics: Sequence And Genome Analysis by David W. Mount.
4. Basic Bioinformatics by S. Ignacimuthu Published by Narosa Publishing House New Delhi.

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## Third Year

### Semester- V

#### Non-Chordate– (4+2 Credits) = 6 Credits

Salient features and outline classification (up to orders) of various Non-chordate Phyla and related type study and topics as covered under respective Phyla.

Protozoa: *Paramecium* with particular reference to locomotion, nutrition, osmoregulation and reproduction.

Porifera: *Sycon* with reference to structure, reproduction and development. Canal system, and affinities of Porifera.

Coelenterata: *Aurelia* with reference to structure, reproduction and development. Polymorphism in Coelenterata. A brief account of Corals and Coral reefs.

Helminthes: Taxonomy, morphology (including adaptations), life cycle, pathogenicity and control measures of *Fasciola*. Parasitic adaptations in Helminthes.

Annelida: *Nereis*- External features, excretory organs and reproduction. Metamerism in Annelida, its origin and significance. Trochophore larva and its significance. Parasitic adaptations in Hirudinaria.

Arthropoda: *Palaemon*- External features and reproduction. *Peripatus*- Its distribution and Zoological importance.

Mollusca: *Pila*- External features, Organs of Pallial complex. Reproduction. A brief account of torsion in Gastropoda.

Echinodermata: *Asterias*- External features. Water vascular system. Mode of feeding and reproduction.

#### Chordate– (4+2 Credits) = 6 Credits

Salient features and outline classification (up to order) of various chordate groups as covered under respective taxonomic groups.

Protochordata: Salient features of body organisation and systematic position of *Balanoglossus* and *Amphioxus* as a type and its affinities. Agnatha: External features of *Petromyzon*.

Pisces: Scales and fins in fishes. Parental care in fishes. Fishes in relation to man.

Amphibia: General characters and affinities of Gymnophiona . Parental care in Amphibia.

Reptilia A brief knowledge of extinct reptiles. Poisonous and non- poisonous snakes. Poison apparatus of snake. Snake venom and anti-venom. Adaptive radiation in reptiles. Adaptations of reptiles to desert life.

Aves: Flightless birds and their distribution. Flight adaptations in birds.

Mammalia: General organisation, distribution and affinities of Prototheria. Economic importance. Adaptive radiation with particular reference to aquatic mammals.

## Practical

### Suggested books:

1. Barnes: Invertebrate Zoology (4<sup>th</sup> ed.), Holt- Saunders, 1980.
2. Hickman, Roberts & Hickman: Integrated principles of Zoology (7<sup>th</sup> ed) Times- mirror, Mosby
3. Kotpal R.L: Modern Textbook Of Zoology : Invertebrates. Rastogi
4. Nigam: Biology of Non-Chordates, Nagin Chand.
5. Parker TJ & haswell WA: Textbook of zoology Vol I & II, Mcmillan.
6. Hyman L: Invertebrate Series, Academic Press

## Semester- VI

### Developmental Biology of Vertebrates (4+2 Credits) = 6 Credits

Gametogenesis: Spermatogenesis and Oogenesis including structure, differentiation and longevity of gametes. Chemical and metabolic events during gamete formation. Types of eggs.

Fertilization: Significance of fertilization, approximation of gametes, Capacitation, Acrosome reaction, formation of fertilization membrane, egg activation, Blockage to polyspermy.

Cleavage: Patterns, control of cleavage patterns, chemical changes during cleavage, totipotency. Blastulation and Gastrulation: A complete study in frog and chick.

Fate maps, their formation and significance.

Foetal membranes: Their formation and functions in chick.

Retrogressive metamorphosis: As exhibited by an ascidian.

Regeneration: Morphallaxis and Epimorphosis, Blastema and its significance, mechanisms as exhibited by invertebrates (*Hydra* and *Planaria*) and Vertebrates (Limb regeneration in Amphibia).

Placentation in mammals.




Embryonic Induction: Origin, structure and significance of primary organizer.

## Practical

### Suggested books:

1. Gilbert: Development Biology Sinauers Ass. Publ. Massachusetts.
2. Wolpert: Analysis of Biological development, Oxford.
3. Kolthoff, Analysis of Biological development, McGraw- Hill Science, New Delhi, India.
4. Balinsky: Introduction to Embryology Saunders co. Philadelphia and London.
5. Berill: Development Biology Tata McGraw Hill.

### General Endocrinology (4+2Credits) = 6 Credits

  
  
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Endocrine system: A brief knowledge of the structure and hormonal functions of the glands namely, Pituitary, Thyroid, Pancreas, Adrenal, Testis and Ovary. Elementary knowledge of the Dwarfism, gigantism, acromegaly, diabetes insipidus, Goitre, Cretinism, Myxoedema, Diabetes mellitus and Addison's disease.

## Fourth Year

### Semester- VII

#### Fundamentals of Immunology (4+1Credits) = 5 Credits

##### Unit - I

###### Introduction and Historical Background: Cells and Organs of Immune System

- Definition, Overview of Immune System- Anatomical, Physiological and Inflammatory Barriers. Major Contribution of Following Scientists- Edward Jenner, Jacob Henle, Louis Pasteur, Joseph Lister, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Emil Von Behring, Jules Bordet, Karl Landsteiner, Jules Freund, Peter Gorer And George Snell, Tiselius & Kabat, Gerald Eldelman & Rodeny Porter, Cesar Milstein & Georges Kohler, Peter Doherty & Rolf Zinkernagel
- Hematopoiesis – Formation of B-Lymphocytes and T-Lymphocytes and Its Regulation. Cells of The Immune System- NK Cells, B-Lymphocytes, T-Lymphocytes, Granulocytic Cells, Dendritic Cells Primary Lymphoid Organs and their Functional Role- Bone Marrow and Thymus. Secondary Lymphoid Organs and Its Functional Role- Lymph Nodes, Spleen, Mucosal-Associated Lymphoid Tissue [MALT], Intraepithelial Lymphocytes [IEL], Cutaneous-Associated Lymphoid Tissue [CALT]

##### Unit - II

###### Antigen and Immunogen, Structure and Function of Immunoglobulins, Structure and Function of MHC:

Antigen- Definition and Its Properties. Immunogen-Definition and Its Properties. Antigenicity Vs. Immunogenicity and Factors Affecting It. Haptens and Adjuvants. Basic Structure of Immunoglobulin. Classes of Immunoglobulin and Its Biological Activities, Major Histocompatibility Complex [MHC] - Structure, Types and Function. Regulation of

*Dr. P. S. Srinivasan*  
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*S. V. Srinivasan*  
*D. Srinivasan*

MHC Expression. Production of Monoclonal Antibodies, Its Mechanism [De Novo and Salvage Pathway] and Application in Research and Health.

### Unit - III

#### Primary And Secondary Line Of Defence [Innate And Acquired Immunity], Antigen-Antibody Interactions:

Innate Immunity- Phagocytic Barriers. Antigen Presenting Cells. Antigen Processing and Presentation. Acquired Immunity- B-Cell Mediated Immunity, T-Cell Mediated Immunity Its Mechanism and Regulation. Immune Memory of B-Lymphocytes.

Structure of Antibody, Treatment of Antibody with Pepsin, Papain, B-Mercaptoethanol and DMSO. Interaction of Antigen-Antibody- Antibody Affinity, Antibody Avidity, Cross Reactivity, Precipitation Reactions and Agglutination Reactions.

### Unit - IV

#### Immune Effector Mechanism, Allergy And Hypersensitivity:

Cytokines- Properties and Its Receptors. Cytokine Secretion by Th1, Th2 And Th17 Subsets And Its Function. The Complement System: Its Components, Functions, Activation and Regulation. Complement Deficiencies.

Allergy and Hypersensitivity: Gell and Coombs Classification, IgE Mediated [Type I] Antibody-Mediated Cytotoxicity [Type II], Immune Complex-Mediated [Type III] and T<sub>DTH</sub>-Mediated [Type IV] Hypersensitivity.

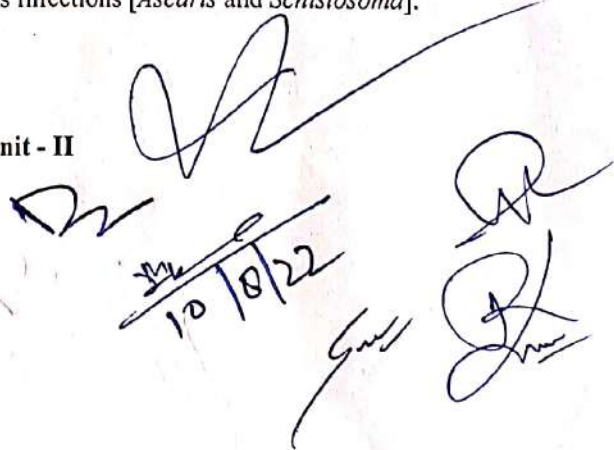
### Paper II Applied Immunology (4+1Credits) = 5 Credits

#### Unit - I

#### Immune Response to Infectious Diseases:

Mechanism of Immune Response During: Viral Infections [Influenza, HIV], Bacterial Infections [*Corynebacteria* and *Mycobacterium*] Protozoan Infection [*Plasmodium*, *Trypanosoma* and *Leishmania*], Helminthes Infections [*Ascaris* and *Schistosoma*].

#### Unit - II

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## Disease of Immune System And Vaccines:

Mechanism of Autoimmune Diseases- Systemic Lupus Erythematous [SLE], Myasthenia Gravis, Rheumatoid Arthritis, Celiac Disease. Cancer of Blood Cells- Lymphoma and Leukemia [Hodgkin and Non-Hodgkin]. Vaccines- Historical Background, Routine Vaccines, DNA Vaccines, Snake-Antidotes. Production of Monoclonal Antibodies and Its Mechanism.

### Unit - III

#### Immunotechnology:

Separation of Immune Cells by Flow cytometry [FACS]: Its Principle and Application. Principle and Application of Immunoprecipitation. Functioning and Application of Microscopes: Immunofluorescence and Confocal. Principle and Application of *in-Situ* Hybridization Technology-FISH [Fluorescence *In-Situ* Hybridization] and GISH [Genome *in-Situ* Hybridization]. Principle, Methodology and Application of Following Techniques- ELISA [Enzyme Linked Immunosorbent Assay], RIA [Radio Immuno Assay], Western Blotting. Allergy Evaluation: Principle and Methodology of Skin Prick Test for Allergy.

### Unit - IV

#### Transplantation Immunology:

Transplantation- History, Graft Vs. Host Rejection Studies for Specific Transplantation I.E Skin Graft, Kidney, Liver and Heart With Reference to Hyperacute, Acute and Chronic Rejection and Its Mechanism. Immunosuppression- Definition, Drugs Used for Immunosuppression and Its Mechanism of Action. Xenotransplantation- Definition and Its Application. HLA Phenotyping, Lymphoproliferation Assay, Its Working Principle and Applications. Blood Groups- MN, ABO Blood Group and Blood Transfusion.

## Paper III Animal Ecology (4+1Credits) = 5 Credits

### Unit-I

- Ecology: Its Relevance to Human Welfare, Subdivisions and Scope. The Environment: Physical Environment; Biotic Environment; Biotic and Abiotic Interactions.
- Habitat and Niche: Concept of Habitat and Niche; Niche Width and Overlap; Fundamental and Realized Niche; Resource Partitioning; Character Displacement.

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- Ecosystem's Structure and Function: Forest and Lake's Biotic and Abiotic Components, Primary and Secondary Productivity, Movement of Energy and Materials, Energy Efficiency Thermal Stratification and Circulation and Lake's Typology.

#### Unit-II

- Limiting Factors: Laws of Limiting Factors, Impact of Temperature, Moisture and pH on Organisms. Structure and Function of Some Indian Ecosystems: Terrestrial (Forest, Grassland) and Aquatic (Fresh Water, Marine and Eustarine).
- Population Ecology: Characteristics of a Population; Population Growth Curves; Population Regulation; Life History Strategies (r And k Selection); Concept of Meta-Population – Demes and Dispersal, Interdemic Extinctions, Age Structured. Altruism (Hamilton's Rule).
- Community Ecology: Community Attributes Namely Dominance, Various Types of Diversity Indices (Lincoln Peterson Index, Simpson Index, Shannon Weiner Index, Berger Parker Index and Brillouin Index). Similarity Coefficient and Niche Concept, Community Nomenclature. Lotka-Voltera Model of Species Competition.

#### Unit-III

- Stressed Water Ecosystems: Point and Non-Point Sources of Pollution, Assessment of Freshwater Pollution Using Various Parameters. Water Quality Monitoring Using Abiotic Factors (E.G. Ph, Oxygen, Nitrate, Ammonia, Phosphate, BOD), Bio-Monitoring (Phytoplankton, Zooplankton and Zoo Benthos), Environmental Impact Assessment (EIA)-Impact Of Environmental Stress on Biotic And Abiotic Factors.
- Eutrophication: Its Causes, Assessment, Consequences and Control. Indicators of Pollution and Eutrophication.
- Species Interactions: Types of Interactions, Interspecific Competition, Herbivory, Carnivory, Pollination and Symbiosis.

#### Unit-IV

- Ecological Succession: Types; Mechanisms; Changes Involved In Succession; Concept Of Climax.
- Biogeography: Major Terrestrial Biomes; Theory of Island Biogeography; Bio-Geographical Zones of India.

- Applied Ecology: Environmental Pollution; Global Environmental Change; Biodiversity: Status, Monitoring and Documentation; Major Drivers Of Biodiversity Change; Biodiversity Management Approaches. Global Conventions on Environmental Pollution (Kyoto Protocol, Montreal Protocol, Earth Summit 2002 and Copenhagen Accord).
- Conservation Biology: Principles of Conservation, Major Approaches to Management, Indian Case Studies on Conservation /Management Strategy (Project Tiger, Biosphere Reserves and Lakes).

## Paper IV Medical Laboratory Techniques

(4+1Credits) = 5 Credits

### Unit I

- Basic Laboratory Principles - Code of Conduct of Medical Laboratory Personnel. Organization and Functioning of Clinical Laboratory. Safety Measures - Safety Equipment's, Safety Symbols.
- Hazards in the Laboratory (Chemical Hazards, Clinical Hazards, Electrical Hazards, Biological Hazards. Waste Disposal.

### Unit II


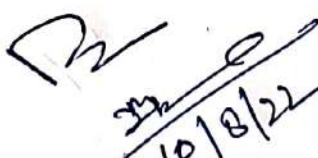

- Introduction of Common Laboratory Equipment's: Hot Air Oven, Incubator, Autoclave, Water Bath and Centrifuges
- Microscope - Fundamentals of Microscopy, Resolution and Magnification, Light Microscopy, Electron Microscopy, PCR Machine (Thermal Cycler), Electrophoresis Unit and UV Trans Illuminator Etc.

### Unit III

- Specimen Collection, Processing and Analytical Techniques Collection and Preservation of Blood, Urine, Stool, Sputum, Pus, Body Fluids and Swab.
- Preparation of Blood Smears. Sources of Biological Variations and Pre-Analytical Variables.

### Unit IV

- Preparation of Reagents: Buffers and pH, Normal, Percent and Molar Solution, Normal Saline -Methods of Measuring Liquids.
- Clinical Laboratory Records - Modern Laboratory Set Up - Quality Control: Accuracy, Precision, and Reference Values.
- Disposal of Biomedical Waste
- Laboratory Safety Protocols and Guidelines

  
  
  
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## Semester- VIII

### Paper I General Ichthyology (4+1Credits) = 5 Credits

#### Unit I

- Classification of Fishes, Systematic Position, Habit and Habitat, Morphology, Distribution, Significance and Affinities of Holocephali and Dipnoi.
- Fins, Their Origin and Evolution; Locomotion in Fishes.
- Histomorphology and Elementary Physiology (A) Digestive System (With Particular Reference to Food And Feeding Habits of Freshwater Fishes) (B) Excretory System (With Particular Reference to Acid Base Balance and Osmoregulation.) (C) Accessory Respiratory Organs in Fishes.

#### Unit II



- General Survey of the Marine, Estuarine and Inland Capture Fisheries of India with Particular Reference to Fishery Resources of Uttaranchal. Methods of Fishing: Fishing Gears and Crafts. Cold Water Fishery Sewage-Fed Fishery and Shell –Fish Fishery.
- Nutrition and Growth Including Age and Growth Relationship, Chemical Composition of Fish Flesh, Length –Weight Relationship, Natural Food and Artificial Feed and Their Role in Fish Culture. Plankton and Benthos in Relation to Fish Production

#### Unit III

- Electric Organs in Fishes.
- Brief Knowledge of Sexual Dimorphism, Courtship And Parental Care. Migratory Instincts, Hill Stream Adaptations
- Reproduction in a Major Carps- Structure Of Gonad, Spawning, Early Development And Metamorphosis. Microscopic Structure And Hormonal Functions Of The Following Endocrine Glands: Pituitary, Thyroid, Pancreas, Adrenal, Corpuscles Of Stannins, Ultimobranchial Glands, Caudal Neurosecretory System And Sex Hormones. Current Trends In Induced Breeding In Fishes.

#### Unit IV

  
  
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- Brief Knowledge of Sense Organs: Organs of Smell, Eyes, Hearing, Ampulla of Lorenzini, Bio- Luminescence, Sound Production and Lateral Line System.
- Parental Care in Fishes. Venomous and Non-Venomous Fishes. Fish Pheromones. Coloration in Fishes.

## **Paper II Applied Ichthyology (4+1Credits) = 5 Credits**

### **Unit I**

- Important Cultivable Fishes
- Important Cultivable Shellfishes
- Biology of Cultivated Fish and Shellfish

### **Unit II**

- Ecology and Productivity of Fish Ponds. Pollution in Relation to Fisheries.
- Carp Culture: Mono Culture, Poly Culture and Composite Fish Culture. Live Fish Culture. Management Practices: Weed, Insect and Carnivorous Fishes.

### **Unit III**

- Maturation and Fecundity, Spawning and Seed Collection, Induced Breeding, Hatching Techniques and Hatcheries, Nursery Management, Packing and Transport of Fish.

### **Unit IV**

- Integrated Aquaculture: Fish-Cum Poultry, Fish-Cum Duckery, Fish-Cum Piggery, Paddy-Cum Fish Culture And Dairy-Cum Fish Culture. Induced Spawning and Hybridization. Factors Responsive for Induced Breeding, Hypophysation . Use of Different Synthetic and Natural Hormones.
- Larvivorous Fishes and Public Health. Fish Diseases and Their Management. Exotic Fishes and Their Merits and Demerits, Cryopreservation of Gametes and Embryos. Ornamental Fish Culture.

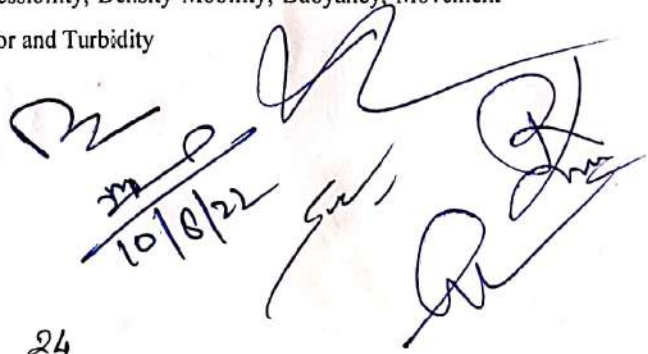
## **Paper III Basic Limnology (4+1Credits) = 5 Credits**

### **Unit I**

- Introduction and Development of Limnology in India
- Inland, Waters Distribution of Inland Waters: Ponds, Lakes, Streams, River

### **Unit II**

- Lakes: Thermal Classification of Lakes, Famous Lakes of India and World, Nature of Inland Water Environment.
- Physical Characteristics: Pressure, Compressibility, Density Mobility, Buoyancy, Movement of Water Thermal Stratification Light, Color and Turbidity


  
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### Unit III

- Chemical Characteristics: Dissolved Gases – Oxygen, Carbon Dioxide and Other Dissolved Gases Dissolved Solids and Dissolved Organic Matter Influence of Physical and Chemical Conditions on Living Organisms in Inland Water Bodies.
- Planktonic Organisms: Classifications of Organisms in Water Distribution of Plankton Food For Plankton Organisms

### Unit IV

- Biological Productivity, Circulation of Food Material, Classification of Lakes Based on Productivity, Laws of Minimum, Biotic Potential and Environmental Resistance, Quantitative Relations in a Standing Crop
- Water Pollution, Eutrophication, Algal Blooms, Water Borne Diseases and Drinking Water Parameters
- Bioremediation of Polluted Water Bodies.

## Paper IV Animal Ecology (4+1Credits) = 5 Credits

### Unit-I

- Ecology: Its Relevance to Human Welfare, Subdivisions and Scope. The Environment: Physical Environment; Biotic Environment; Biotic and Abiotic Interactions.
- Habitat and Niche: Concept of Habitat and Niche; Niche Width and Overlap; Fundamental and Realized Niche; Resource Partitioning; Character Displacement.
- Ecosystem's Structure and Function: Forest and Lake's Biotic and Abiotic Components, Primary and Secondary Productivity, Movement of Energy and Materials, Energy Efficiency Thermal Stratification Circulation and Lake's Typology.

### Unit-II

- Limiting Factors: Laws of Limiting Factors, Impact of Temperature, Moisture and pH on Organisms. Structure and Function of Some Indian Ecosystems: Terrestrial (Forest, Grassland) and Aquatic (Fresh Water, Marine, Eustarine).
- Population Ecology: Characteristics of a Population; Population Growth Curves; Population Regulation; Life History Strategies (r and k Selection); Concept of Meta-Population – Demes and Dispersal, Interdemic Extinctions, Age Structured. Altruism (Hamilton's Rule).

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- Community Ecology: Community Attributes Namely Dominance, Various Types of Diversity Indices (Lincoln Peterson Index, Simpson Index, Shannon Weiner Index, Brillouin Index and Berger Parker Index). Similarity Coefficient and Niche Concept, Community Nomenclature.

### Unit-III

- Stressed Water Ecosystems: Point and Non-Point Sources of Pollution, Assessment of Freshwater Pollution Using Various Parameters. Water Quality Monitoring Using Abiotic Factors (E.G. pH, Oxygen, Nitrate, Ammonia, Phosphate, BOD), Bio-Monitoring (Phytoplankton, Zooplankton and Zoo Benthos), Environmental Impact Assessment (EIA)- Impact of Environmental Stress on Biotic and Abiotic Factors.
- Eutrophication: Its Causes, Assessment, Consequences and Control. Indicators of Pollution and Eutrophication.
- Species Interactions: Types of Interactions, Interspecific Competition, Herbivory, Carnivory, Pollination and Symbiosis.

### Unit-IV

- Ecological Succession: Types; Mechanisms; Changes Involved in Succession; Concept of Climax.
- Biogeography: Major Terrestrial Biomes; Theory of Island Biogeography; Bio-Geographical Zones of India.
- Applied Ecology: Environmental Pollution; Global Environmental Change; Biodiversity: Status, Monitoring and Documentation; Major Drivers of Biodiversity Change; Biodiversity Management Approaches. Global Conventions on Environmental Pollution (Kyoto Protocol, Montreal Protocol, Earth Summit 2002 and Copenhagen Accord).
- Conservation Biology: Principles of Conservation, Major Approaches to Management, Indian Case Studies on Conservation /Management Strategy (Project Tiger, Biosphere Reserves and Lakes).

## Practical

### Suggested books:

1. Srivastava CBL: Fish Biology, Narendra Publishing House.
2. Singh HR: Advance in Fish Biology, Hindustan Publishing Corp.

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3. Munshi & Munsri: Fundamental of Freshwater Biology. Narendra Publishing House.
4. Kyle: The biology of Fishes.
5. Khanna & Singh: Fish and Fisheries.

## Minor/Elective

### Chronobiology (4+1Credits) = 5 Credits

Introduction to chronobiology. Evolution of biological timing system; Clocks, genes and evolution; Adaptive functional significance of biological clocks.

Studying biological clocks; Biological Rhythms - Ultradian, Tidal/Lunar, Circadian and Circannual rhythms; Temperature effects and compensation; Perception of natural zeitgeber signals; Geophysical environment - Seasons; proximate and ultimate factors.

Entrainment, masking and zeitgeber cycles; parametric and non-parametric entrainment; Entrainment models; Phase shift, Phase response curves (PRC) and phase transition curves (PTC); Organization of circadian system in multicellular animals; Concept of central and peripheral Clock system in multicellular animals; SCN suprachiasmatic nucleus as the main vertebrate clock, concept of core and shell.

Diversity and complexity of the clock system, Melatonin: input and output signal of the clock system. Photoreception and photo-transduction. Human Health and diseases-chronopharmacology, chronomedicine, chronotherapy.

or

### Applied Zoology (4+1Credits) = 5 Credits

Parasitic protozoa and Helminthes: *Ancylostoma, Schistosoma, Ascaris, Filaria* (including periodicity).

Detailed information on:

- (a) Aquaculture
- (b) Sericulture
- (c) Apiculture
- (d) Lac culture



Section - B



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Bionomics and control measures of the common pests of fruits (*Papilio demoleus* and *Quadraspidiotus perniciosus*), Vegetables (*Thrips tabaci* and *Aulacophora foveicollis*) and stored grains (*Callosobruchus chinensis* and *Trogoderma granarium*). Polyphagous pests (Locust and Termites).

Pest management, including insect pest control and integrated pest management. A note on Bioethics.

Economic importance of birds and mammals.

Common Pest of Uttarakhand.

or

### **General Biotechnology (4+1Credits) = 5 Credits**

Origin and definition, scope and importance of Biotechnology. Recombinant DNA technology and Genetic engineering. Restriction enzymes and cloning techniques used in recombinant DNA technology, DNA fingerprinting, Biochips.

Biotechnological innovations in the area of medical, agricultural industrial & forensic sciences.

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# Fifth Year

## Semester- IX

### Paper I Systematics And Applied Entomology (4+1Credits) = 5 Credits

#### Unit I

- Ancestry and Evolution of Insects
- Classification of Insects
- Principles of Construction and Use of Dichotomous Keys in Insect Identification
- Methods of Collection, Preservation and Culture of Insects
- Parental Care in Insects

#### Unit II

- Brief Knowledge of Habit, Habitats and General Characters of the Following Orders With Special Reference to the Families Mentioned: Thysanura (Machilidae, Lepismatidae), Collembola, Odonata, Orthoptera (Acrididae, Tettigonidae, Gryllidae), Phase Theory in Locusts, Phthioptera (Anoplura, Mallophaga), Isoptera, Thysanoptera, Heteroptera (Pentatomidae, Belostomatidae), Homoptera (Aphidae, Coccidae), Coleoptera (Coccinellidae, Curculionidae), Lepidoptera (Noctuidae, Nymphalidae), Hymenoptera (Ichneumonidae, Formicidae); Diptera (Muscidae, Syrphidae)

#### Unit III

- Principles and Practices of Pest Control:
- Pest Control Procedures: Natural Control, Applied Control (Cultural, Biological and Insecticidal)
- Modes of Action of Insecticides, Factors Affecting Toxicity of Insecticides
- Non-Insecticidal Methods : Antifeedents, Attractants and Repellents, Feeding Deterrents, Chemosterilants, Pheromones and Insect Growth Regulators (IGR's)
- Integrated Pest Management (IPM)
- Insecticide Application Equipments: Sprayers, Dusters, Granule Applicators

Distribution, Habit and Habitats, Life-Cycle, Nature of Damage and Control of Pests of: **Stored Grains** (*Sitophilus Oryzae*, *Tribolium Castaneum*, *Callosobruchus Chinensis*); **Sugarcane** (*Pyrilla Perpusilla*, *Chio Infuscatellus*); **Paddy**(*Leptocorisa Acuta*, *Hieroglyphus Banian/Nigrorepletus*), **Cotton** (*Dysdercus Koengii*, *Pectinophora Gossypiella*); **Cereals** (*Helioverpa Armigera*, *Agrotis Ypsilon*) **Vegetables**((*Raphidopalpa* (=Aulacophora) *Foveicollis*, *Pieris Brassicae*); **Fruits**(*Bactrocera* (= *Dacus*) *Cucurbitae*, *Papilio Demoleus*); **Forests** (**Defoliator**: *Tasar* Silkworm, *Antheraea Paphia*; **Sap-Sucker** Of **Khamer** Or **Gambar**,

*Tingis Beesoni*; **Teak Borer**, *Aeolesthes Holosericea*); And **Polyphagous Pests** (Locusts, Termites)

#### Unit IV

**Lac Industry:** Strains of Lac Insects, Lac Cultivation, Composition and Uses of Lac

**Apiculture:** Kinds of Honey Bees and Bee Hives, Structure of Typical Bee Hive Organization of Honey Bees, The Language of Honey Bees, Bee Keeping Methods, Economic Importance and Diseases of Honey Bees. Parasites of Honey Bee (*Varroa Destructor*, *Varroa Jacobsoni* and *Galleria Mellonella*).

**Sericulture:** Mulberry and Non-Mulberry Sericulture, Composition Processing of Silk and Silk Industry in India. Diseases of Silkworm (White Muscadine and Pebrine Disease).

**Life-Cycle and Control of Insects of Medical Importance of Man and Animals:** House Flies, Mosquitoes, *Phelbotomus* (Sandfly) and *Tabanus* (Horse Fly)

### Paper II Biology of Insects (Morphology, Physiology & Development) (4+1Credits) = 5 Credits

#### Unit I

- Integument: Structure, Functions and Modifications of Insect Cuticle, Moulting and Sclerotization
- Structure of an Insect Head, Thorax and Abdomen; Appendages of Head (Mouthparts and Antennae) and Thorax (Legs and Wings)
- Structure of a Wing of an Insect, Types of Wings, Hypothetical Wing Venation, Wing-Coupling Mechanisms and Flight Mechanism
- Structure and Modifications of Male and Female Genitalia in Insects

#### Unit II

- Structure and Modifications of Alimentary Canal; Food and Feeding Mechanism of a Generalised Insect With Special Reference to Physiology of Digestion in Different Insects
- Structure and Functions of Blood and Mode of Circulation in Insects
- Principal Organs of Excretion of Insects Found in Different Habitats, Physiology of Excretion With Special Reference to Osmoregulation in Insects

#### Unit III

- Structure and Functioning of Various Types of Respiratory Organs, Modes of Respiration, Physiology of Respiration in Terrestrial, Aquatic and Endoparasitic Insects
- Generalized Plan of Nervous System in Insects and Its Modifications
- Neuroendocrine System in Insects and The Role Of Neurosecretion In Various Metabolic Activities, Metamorphosis and Development of Insects

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- Structure and Functions of Different Types of Visual and Sound Producing Organs in Insects

#### Unit IV

- Structure, Function and Physiology of Mechanoreceptors and Chemo Receptors in Insects
- Bioluminescence: Light Producing Organs, Mechanism and Significance of Light Production in Insect
- Structure of Pheromone Producing Glands, Different Types of Pheromones and their Chemical Nature
- Structure and Modification of Male and Female Reproductive Systems in Insects
- Development: Structure of Egg, Maturation, Cleavage, Blastokinesis, Formation of Germ Layers and Segmentation; Different Types of Larvae and Pupae, Polyembryony and Parthenogenesis in Insects

### PAPER III Economic Zoology and Vermicology

(4+1Credits) = 5 Credits

#### Unit I

- The General Study of Parasites in Terms of Morphology, Mode of Transmission, Symptoms, Prevention and Control.
- Types of Parasites Unicellular Parasite. Protozoans (*Entamoeba Histolytica*, *Plasmodium* Spp.,) *Trypanosoma* Spp. *Leishmania* Spp. Etc.) *Giardia* and Vector Biology.
- Study: Multicellular Parasites, Platyhelminthes (Tape Worms and Liver Flukes) Aschelminthes (*Ascaris*) Nematoda- *Sea Eligans*.

#### Unit II

- Pests and Parasites, Apiculture, Sericulture, Lac Culture, Pisciculture, Dairy and Farming's Products.
- Pesticides (Organochlorines, Organophosphates, Carbanates, Pyrethroids, Triazines, Bordeaux Nixture), Mode of Action of Pesticides, Advantages and Disadvantages of Pesticides Hazards of Pesticides,
- Biological Methods of Pest Control.

#### Unit III

- Earthworm Diversity: Classification Earthworm Types: White Worm Behavior of Earthworms As Indicators of Soil Fertility, Earthworms As Bioreactors; Earthworms and Plant Growth, Organic Matter-Dynamics and Nutrient Cycling, Feeding Habit and Food
- Vermicomposting :Advantages of Vermicomposting, Vermicomposting in Daily Life, Vermiculture Vs. Vermicomposting, Chemical Composition of Vermicompost

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Vermicomposting at Home and Agricultural Farm; The Business of Worms; Interaction of Vermicompost Earthworms.

#### Unit IV

- Earthworm Bio-Technology: Fundamentals of Sustainability; Enrichment of Vermicompost and Earthworms for Sustainable Production, Earthworms in Bio-Remediation, Earthworms in Alternative Medicine, Earthworm Meal Production Transgenic Earthworms.
- Organic Farming: Eco-Friendly Farming System Technologies. Evaluation Study of Ecological Constraints (Climatic and Edaphic,). Appropriate Technologies, in Agro-Forestry, Natural-Management, Planted Forests, (Ranching, Farmers Perception to Organic Farming and any Case Study).

### Paper IV Wildlife Conservation (4+1Credits) = 5 Credits

#### Unit I

- Indian Wildlife: Introduction, Distribution of Wildlife in Ecological Subdivision of India, IUCN Categories
- Protected Area Network: National Parks, Wildlife Sanctuaries, Biosphere Reserves and Zoos in India, Gene Pool, Habit, Habitat and Breeding Biology of Few Mammals (Viz., Elephant and Tiger).

#### Unit II

- Reasons For Wildlife Depletion: Habitat Fragmentation, Habitat Destruction, Commercial Wildlife Exploitation, Overgrazing Etc.,
- Wildlife Conservation (Policies and Programmes), Special Projects for Endangered Species (Project Tiger, Gir Lion Sanctuary Project and Crocodile Breeding Project).

#### Unit III

- Principle and Practice of Wildlife Management: Management of Special Habitats; Riparian Zones, Grasslands Introduction to Conservation Biology, Conservation Values and Ethics of Conservation of Natural Resources.

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- Conservation of Biodiversity, Patterns and Processes, Concepts of Biodiversity, Levels of Biodiversity, Genetic Diversity, Intra Specific Diversity, Species Richness, Richness of Higher Taxa, Ecosystem and Biome Diversity.

#### Unit IV

- International Conventions on Conservation (Ex-Situ and in-Situ Conservation, Conservation Breeding (E.G. Vulture, Pygmy Hog, Gharial, Etc.), Institutions and their Role in Conservation (Zoos, Natural History Museums and Collections, Zoological Survey of India and Its Regional Centres.
- National and International Zoological Institutes, Societies and Academic Bodies.
- Brief Account of Wildlife Acts and Their Amendments in India and World. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

## Semester- X

### Paper I Animal Biotechnology (Animal Cell Culture)

(4+1Credits) = 5 Credits

#### Unit I

- Animal Cell Culture: Equipment and Materials for Animal Cell Culture Technology. Design and Layout of Culture Room, Sterilization and Aseptic Techniques.
- Culture Medium: Natural Media, Synthetic Media, Sera. Introduction to Balanced Salt Solutions and Simple Growth Medium. Brief Discussion on the Chemical, Physical and Metabolic Functions of Different Constituents of Culture Medium, Role of Carbon Dioxide, Serum and Supplements in Animal Cell Culture.
- Characteristics of Cells in Culture: Contact Inhibition, Anchorage Dependence and Cell-Cell Communication.

#### Unit II

- Mechanical and Enzymatic Disaggregation of Tissue and Setting up of Primary Cultures, Candling of Eggs, Preparation of Chick Fibroblast, Culture of Lymphocytes For Chromosomal Studies. Roller and Suspension Culture Techniques. Large-Scale Production of Cells Using Bioreactors, Micro- Carriers and Perfusion Techniques.
- Measurement of Viability and Cytotoxicity. Biological Characterization of the Cultured Cells, Karyotyping, Cryopreservation and Revival. Detection of Contaminants in Cell Cultures.

### Unit III

- Fermentation Technology for the Growth of Animal Cells and their Products (Bioreactors, Hollow Fiber Reactors, Air-Lift Fermentors, Chemostats and Microcarriers). Established Cell Line Cultures: Definition of Cell Lines, Maintenance and Management; Cell Adaptation.
- Stem Cell Cultures, Embryonic Stem Cells and their Applications. Somatic Cell Genetics. Organ and Histotypic Cultures.
- Cell Cloning, Cell Synchronization and Cell Manipulation. Various Methods of Separation of Cell Types, Advantages and Limitations; Flow Cytometry. Production and Characterization of Monoclonal Antibodies and their Application.

### Unit IV

- Commercial Applications of Animal Cell Culture: Cell Culture Based Vaccines, Tissue Culture as a Screening System; Cytotoxicity, *in-vitro* Testing of Drugs and Diagnostic Tests. Mass Production of Biologically Important Compounds (E.G. Vaccines and Pharmaceutical Proteins).
- Production of Recombinant Hemoglobin, Blood Substituents, Artificial Blood. Harvesting of Products, Purification and Assays. Three Dimensional Cultures and Tissue Engineering (Artificial Skin and Artificial Cartilage).

## Paper II Animal Biotechnology(Transgenics, Cloning And IPR) (4+1 Credits) = 5 Credits

### Unit I

- Gene Transfer Technology in Animals: Viral And Non-Viral Methods, Sperm Mediated Gene Transfer, Transfection of Animal Cell Lines and their Immortalization, Gene Knock Out Animal Models, Current Status of Production of Transgenic Animals.
- Animal Cloning: Techniques, Relevance, Case Studies and Ethical Issues.

### Unit II

- In Vitro Fertilization (IVF) and Embryo Transfer (ET) Technology in Humans; Superovulation, Micromanipulation, IVF And Embryo Culture in Farm Animals (E.G. Cow); Embryo Transfer In Cattle, Gene Transfer or Transfection (Using Eggs And Cultured Stem Cells): Targeted Gene Transfer; Transgenic Animals (Mice, Sheep, Pigs, Rabbits, Goats, Cows and Fish).

### Unit III

- Introduction to Biosafety Regulations; Primary Containment for Biohazards and Biosafety Levels, Biosafety Guidelines – Government of India. Definition of Genetically Modified Organisms (Gmos) & Living Modified Organisms (Lmos); Roles of Institutional Animal

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Ethical Committee, Review Committee on Genetic Manipulation (RCGM), Genetic Engineering Approval Committee (GEAC) Etc.

- Prevention of Cruelty on Animals Act Govt. of India, Concept of Bioethics, Public Concerns on Human Genome Research and Transgenics – Genetic Testing and Screening, Ethics in Clinical Trials and Good Clinical Practices(GCP), Ethical, Legal and Social Implications (ELSI) & Human Genome Project; Ethics in Human Cloning and Patenting Human Genes.

#### Unit IV

- Intellectual Property Rights and Its Types-Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs, Basics of Patents (Types, Patent Application and Specifications), Concept of Prior Art and Patent Filing Procedures, Process Patent Vs Product Patent.
- Introduction to General Agreement on Tariffs and Trade (GATT), World Trade Organization (WTO), World Intellectual Property Organization (WIPO) and Trade Related Intellectual Property Rights (TRIPS).

### Paper III Medical Laboratory Techniques (4+1Credits) = 5 Credits

#### Unit I

- Basic Laboratory Principles - Code of Conduct of Medical Laboratory Personnel. Organization and Functioning of Clinical Laboratory. Safety Measures - Safety Equipment's, Safety Symbols.
- Hazards in the Laboratory (Chemical Hazards, Clinical Hazards, Electrical Hazards, Biological Hazards. Waste Disposal.

#### Unit II

- Introduction of Common Laboratory Equipment's: Hot Air Oven, Incubator, Autoclave, Water Bath, Centrifuges
- Microscope - Fundamentals of Microscopy, Resolution and Magnification, Light Microscopy, Electron Microscopy, PCR Machine (Thermal Cycler), Electrophoresis Unit and UV Trans Illuminator Etc.

#### Unit III

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- Specimen Collection, Processing and Analytical Techniques Collection and Preservation of Blood, Urine, Stool, Sputum, Pus, Body Fluids and Swab.
- Preparation of Blood Smears. Sources of Biological Variations, Pre-Analytical Variables.

#### Unit IV

- Preparation of Reagents: Buffers and pH, Normal, Percent and Molar Solution, Normal Saline - Methods of Measuring Liquids.
- Clinical Laboratory Records - Modern Laboratory Set Up - Quality Control: Accuracy, Precision, and Reference Values.
- Disposal of Biomedical Waste
- Laboratory Safety Protocols and Guidelines

### Paper IV Wildlife Conservation(4+1 Credits) = 5 Credits

#### Unit I

- Indian Wildlife: Introduction, Distribution of Wildlife in Ecological Subdivision of India, IUCN Categories
- Protected Area Network: National Parks, Wildlife Sanctuaries, Biosphere Reserves and Zoos in India, Gene Pool, Habit, Habitat and Breeding Biology of Few Mammals (Viz., Elephant and Tiger).

#### Unit II

- Reasons for Wildlife Depletion: Habitat Fragmentation, Habitat Destruction, Commercial Wildlife Exploitation, Overgrazing Etc.,
- Wildlife Conservation (Policies and Programmes), Special Projects for Endangered Species (Project Tiger, Gir Lion Sanctuary Project and Crocodile Breeding Project).

#### Unit III

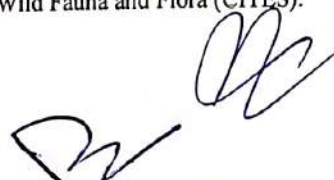
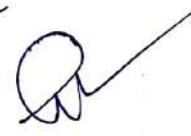

- Principle and Practice of Wildlife Management: Management of Special Habitats; Riparian Zones, Grasslands Introduction to Conservation Biology, Conservation Values and Ethics of Conservation of Natural Resources.

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- Conservation of Biodiversity, Patterns and Processes, Concepts of Biodiversity, Levels of Biodiversity, Genetic Diversity, Intra Specific Diversity, Species Richness, Richness of Higher Taxa, Ecosystem and Biome Diversity.

#### Unit IV

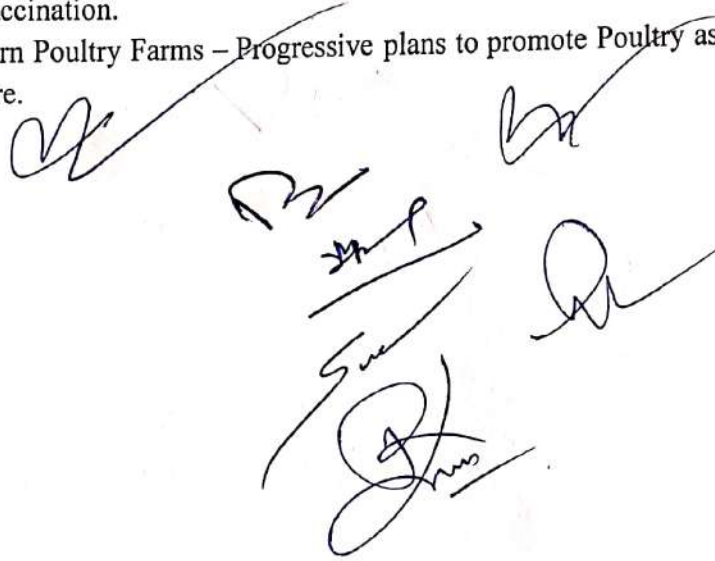
- International Conventions on Conservation (*Ex-Situ and in-Situ* Conservation, Conservation Breeding (E.G. Vulture, Pygmy Hog, Gharial, Etc.), Institutions and Their Role in Conservation (Zoos, Natural History Museums and Collections, Zoological Survey of India and Its Regional Centres).
- National and International Zoological Institutes, Societies and Academic Bodies
- Brief Account of Wildlife Acts and their Amendments in India and World. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

  
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## Minor Elective: Applied Zoology

### Poultry Farming

- Unit 1:** External morphology of variety of Fowls such as Plymouth Rock, Light Sussex, Minorca, Rhode Island, Red and White Leghorn.
- Unit 2:** Classification of Fowls based on their use : Meat type such as Broilers, Egg type such as White Leghorn and Commercial layers, Dual purpose varieties, Game and Ornamental purpose varieties.
- Unit 3:** Feeding Poultry – Management of Egg Layers – Management of Broilers in large scale farms.
- Unit 4:** Poultry diseases Viral, Bacterial, Fungal, Protozoan and Parasitic Lice etc., Prevention and precautions during vaccination.
- Unit 5:** Management of a modern Poultry Farms – Progressive plans to promote Poultry as a Self-Employment venture.

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## Minor Elective: Applied Zoology

### Apiculture

- Unit 1:** History – Biology and classification of honey bee species of honey bees Social organization of honey bee colony.
- Unit 2:** Bee hive – Flora for apiculture – Selection of bees for apiculture, Method of bee Keeping – Indigenous method of Extraction of honey
- Unit 3:** Modern method of apiculture – Appliances for modern method. Diseases of Honey bee and control measures.
- Unit 4:** Products of bee keeping : Honey – Bee wax and Bee Yeman – Honey : Production, Chemical composition – Economic importance of Honey bee wax.
- Unit 5:** Bee enemies – Bee keeping industry – Recent efforts – Modern method in employing honey bees for cross pollination in horticultural gardens

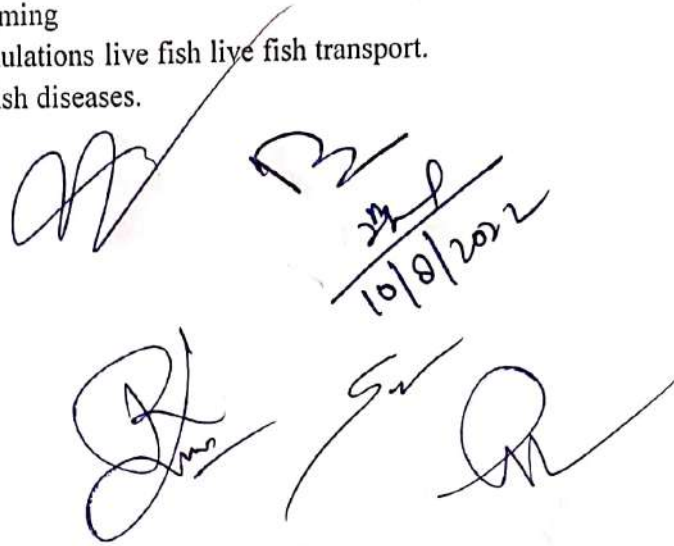
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## Minor Elective: Applied Zoology

### Pisciculture

- Unit 1:** Scope of Aquaculture: Importance of cultivable fresh water, marine ornamental species.  
**Unit 2:** Fish farm Maintenance – Farm management technique, water quality, temperature and accessories in Farm management viz Aerator, Filter, paddler  
**Unit 3:** Fish culture technique, Monoculture, Polyculture and monosex culture, Induced fish breeding, Integrated fish farming  
**Unit 4:** Fish nutrition and fish formulations live fish live fish transport.  
**Unit 5:** Prevention and control of fish diseases.

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Minor Elective: Applied Zoology  
Aquarium Fish Keeping

- Unit 1:** The potential scope of Aquarium Fish Industry as a Cottage Industry. Exotic and Endemic species of Aquarium Fishes
- Unit 3:** Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish
- Unit 4:** Food and feeding of Aquarium fishes – Use of live fish feed organisms. Preparation and composition of formulated fish feeds
- Unit 5:** Live fish transport - Fish handling, packing and forwarding techniques.
- Unit 6:** General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry.
- Unit 7:** Health Education in India – WHO Programmes – Government and Voluntary Organizations and their health services – Precautions, First Aid and awareness on sporadic diseases.

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Sri Dev Suman Uttarakhand University, Badshahithaul, New Tehri

NEP-2020

## Practical Syllabus

### Certificate course in Clinical Diagnostics & Biochemistry

Paper Code: ZOO101T (Animal Physiology and Biochemistry)

#### Animal Physiology

1. Preparation of hemin crystals, RBCs and WBCs count
2. Calculation of Hb. Concentration
3. Blood group test

#### Biochemistry

1. Identification of unknown carbohydrates in given solutions (Starch, Sucrose, Lactose, Galactose, Glucose, Fructose)
2. Colour reactions to identify functional group in the given solution of proteins
3. Study of activity of salivary amylase under optimum conditions
4. Paper chromatographic separation of amino acids

Paper Code: ZOO201T (Genetics and Cell Biology)

#### Genetics

1. Problems based on Mendal's law
2. Problems based on sex-linked inheritance
3. Study of different types of chromosomes with the help of prepared slides
4. Preparation and analysis of salivary gland polytene chromosomes of Drosophila larvae
5. Study of Linkage, recombination, gene mapping using the data
6. Study of Human Karyotypes (normal and abnormal)

#### Cell Biology

1. Cell Structure and Cell Division- Prepared slides/photographs
2. Preparation of onion root tip for the stage of mitosis
3. Preparation of giant chromosome
4. Study of different stages of cell cycle by squash technique

Minor Elective: Environmental Science and Basic concepts of Ecology

#### Environmental Science

1. Models Based on different aspects of ecology
2. Population study of available terrestrial and aquatic animals

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3. Physico-chemical study of soil and water (pH, DO, Free CO<sub>2</sub>, Turbidity etc)
4. Study of an ecosystem, its biotic components and food chains

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# Practical Syllabus

## Diploma in Molecular Sciences & Clinical Microbiology

Paper Code: ZOO301T Molecular Biology, Toxicology and Histology

### Molecular Biology

1. Study of Watson & Crick Model of DNA through model/photographs
2. Study of Clover leaf structure of tRNA through model/photographs
3. Isolation of chromosomal DNA from bacterial cells
4. Comments with drawings of DNA replication, retrovirus and central dogma of molecular biology.
5. Estimation of DNA by diphenyl amine method

### Toxicology

1. Estimation of LC50 and LD 50 using insects and fishes
2. Pesticide residue analysis of contaminated soil, vegetable and water using TLC, GLC and HPLC
3. Estimation of uncertainty and variability in pesticide residue analysis
4. Studies on dissipation of pesticides from soil and half life estimation

### Histology

1. Preparation of permanent slides of various tissues
2. Study of permanent slides of spinal cord, duodenum, liver, lung, kidney, bone, cartilage

Paper Code: ZOO401T (Microbiology and Animal Behaviour)

### Microbiology

1. Study microorganisms in a sample of river water
2. Culture of *Paramecium* in laboratory condition
- 3.
4. Staining technique- simple and differential
5. Staining techniques – Gram staining, spore staining
6. Preparation and sterilization of media
7. Preparation of broth and agar media and agar slants
8. Aseptic transfer of microorganisms
9. Streak plate method for isolation of pure culture
10. Antibiotic sensitivity test – Disc diffusion method
11. Water quality testing using coliforms

### Animal Behaviour

1. Courtship and mating behaviour in *Drosophila*
2. Behavioural profiling of a primate *Macaca muleta*

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3. Fixed action pattern in spider
4. study the geotaxis, phototaxis, chemotaxis and hydrotaxi of earthworm

### Minor Elective: Bio-Instrumentation, Bioinformatics and Biostatistics

#### Bio-Instrumentation

1. Study the resolving powers of different microscopes
2. Study of scanning and transmission microscopes
3. Different fixation and staining techniques for EM
4. Study of Laminar air flow
5. Study of incubators
6. Study of Spectrophotometry
7. Study of pH Meter
8. Study of Electrophoresis
9. Study of Centrifugation
10. Study of Calorimeter

#### Bioinformatics

1. Nucleic acid and protein sequence databases; data mining methods for sequence analysis
2. Web-based tools for sequence searches, motif analysis and presentation

#### Biostatistics

1. Measures of central tendency and dispersal
2. Probability distributions (Binomial, Poisson and normal)
3. Sampling distribution; difference between parametric and non-parametric statistics
4. Confidence interval; errors; levels of significance; regression and correlation
5. t-test; analysis of variance;  $\chi^2$  test; basic introduction to Muetrovariate statistics, etc

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# Practical Syllabus

## Degree in Bachelor of Zoology

Paper Code: ZOO501T (Non Chordata)

### Non-Chordata

1. Kingdom Protista: Amoeba, Euglena, Plasmodium, Paramecium
2. Phylum Porifera: Sycon (including T.S. and L.S.), Hyalonema, and Euplectella
3. Phylum Cnidaria: Obelia, Physalia, Aurelia, Tubipora, Metridium
4. Phylum Platyhelminthes: Liver Fluke, Taenia solium and Study of its life history stages
5. Phylum Nematelminthes: Male and female Ascaris lumbricoides
6. Phylum Annelida: Aphrodite, Nereis, Pheretima, Hirudinaria
7. Phylum Arthropoda: Palaemon, Cancer, Limulus, Palamnaeus, Scolopendra, Julus, Apis, Peripatus
8. Phylum Mollusca: Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus
9. Phylum Echinodermata: Pentaceros, Ophiura, Echinus, Cucumaria and Antedon

Paper Code: ZOO502T (Chordata)

### Chordata

1. Protochordata: *Balanoglossus, Herdmania, Branchiostoma, Agnatha: Petromyzon*
2. Pisces: *Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Tor putitora*, Hill stream fishes
3. Amphibia: *Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Axolotal larva*
4. Reptilia: *Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis*
5. Key for Identification of poisonous and non-poisonous snakes
6. Aves: Study of six common birds from different orders
7. Mammalia: Sorex, Bat, Funambulus, Loris

### Osteology

1. Disarticulated skeleton of fowl and rabbit
2. Carapace and plastron of turtle /tortoise
3. Mammalian skulls: One herbivorous and one carnivorous animal

Paper Code: ZOO601T (Developmental Biology of vertebrates)

### Developmental Biology of vertebrates

1. Frog & Birds - Study of developmental stages - whole mounts and sections through permanent slides cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole— external and internal gill stages
2. Study of the different types of placentae- histological sections through permanent slides or photomicrographs

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3. Examination of gametes - frog/rat - sperm and ova through permanent slides or photomicrographs
4. Window preparation technique to study the developmental stages of chick
5. *Drosophila* culture and isolation of polytene chromosomes from salivary gland

**Paper Code: ZOO602T (Basic Mammalian Endocrinology)**

**Basic Mammalian Endocrinology**

1. Examination of permanent histological sections of mammalian pituitary, thyroid, parathyroid, pancreas, adrenal glands.
2. Study of different endocrine diseases with the help of charts and photographs
3. Study of prepared slides of embryology of frog and birds

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## Skill Enhancement Course / Vocational Course

### 1. Public health and Hygiene

**Unit 1:** Scope of Public health and Hygiene – nutrition and health – classification of foods – Nutritional deficiencies - Vitamin deficiencies.

**Unit 2:** Environment and Health hazards – Environmental degradation – Pollution and associated health hazards.

**Unit 3:** Communicable diseases and their control measures such as Measles, Polio, Chikungunya, Rabies, Plague, Leprosy and AIDS.

**Unit 4:** Non-Communicable diseases and their preventive measures such as Hypertension, Coronary Heart diseases, Stroke, Diabetes, Obesity and Mental ill-health

### 2. Sericulture

**Unit 1:** Classification of commercial varieties of mulberry. Mulberry plantation establishment and cultivation practices.

**Unit 2:** Diseases of mulberry – fungal, bacterial, viral and Nematode diseases, Deficiency diseases and their remedial measures.

**Unit 3:** Silkworm rearing operations – Chawki rearing and Late age rearing techniques.

**Unit 4:** Physical and commercial characters of Cocoons. Reeling operations, Importance of by-products of Sericulture.

**Unit 5:** Economics of Sericulture – Future and progress of Sericulture Industry in India. Prospects of Sericulture as Self-Employment venture