The Bachelor of Commerce (B.Com.) program at Chaudhary Charan Singh (CCS) University, Meerut, is designed to provide students with a comprehensive understanding of commerce and business principles. The program aims to equip students with the necessary knowledge and skills to excel in various professional roles within the business and financial sectors.

Program Outcomes:

1. Comprehensive Knowledge: Students will gain a solid foundation in key areas such as accounting, finance, economics, business law, and management principles.

2. Analytical Skills: The curriculum emphasizes the development of analytical and critical thinking abilities, enabling students to assess business situations effectively and make informed decisions.

3. Practical Application: Through case studies, projects, and internships, students will learn to apply theoretical concepts to real-world business scenarios, enhancing their practical understanding.

4. Ethical Awareness: The program instills a sense of professional ethics and social responsibility, preparing students to navigate the business world with integrity.

5. Communication Skills: Effective communication is a key focus, ensuring that graduates can convey ideas clearly and work collaboratively in diverse business environments.

Key Subjects in the B.Com. Syllabus:

Principal
Deva Nagri College
Meerut

Prof. (Dr.) S.K. Sharma
Head
Department of Commerce
Deva Nagri College Meerut

Financial Accounting: Introduction to accounting principles, preparation of financial statements, and understanding of accounting standards.

Business Economics: Study of micro and macroeconomic concepts relevant to business decision-making.

Corporate Accounting: Advanced accounting topics, including company accounts, amalgamation, and reconstruction.

Business Law: Overview of legal aspects affecting businesses, such as contract law, company law, and consumer protection.

Management Principles: Fundamentals of management, including planning, organizing, leading, and controlling.

Marketing and Human Resource Management: Basics of marketing strategies and human resource practices.

Income Tax and Auditing: Understanding of taxation policies and auditing procedures.

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Meerut

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Head
Department of Commerce
Deva Nagri College, Meerut

Course prerequisites: To study this course, a student may have any subject inclass12th.

Suggested equivalent online courses:

There are lots of online certificate and diploma courses available in various universities and institutions.

After completing B.Com. student has a vast choice in different fields where they can explore their inner talent. Job areas for commerce graduate are in Business Consultancies, Educational Institutes, Industrial Houses, Public Accounting Firms, Policy Planning, Foreign Trade, Banks, Budget Planning, Inventory Control, Merchant Banking, Marketing, Working Capital Management, Treasury and Forex Department, Investment Banking and so many for them explore further.

Greater employment opportunities

In many career sectors, such as Higher Education, Administration, public affairs, and social services, a master's degree is considered a bachelor's as the minimum requirementfor employment.

Earlier with a bachelor's degree like B.Com. one could secure an entry-level position asan admissions counselor, academic adviser, or student services coordinator. While holding a graduate degree is not a guarantee of ultimate success, it certainly opens manymore doors for employment.

Plethora of Specialisation

You may get options for specialisation during your bachelor's in Commerce degree. Some of them are Taxation, Marketing, Computers, etc. But, most of the times, there is a general degree i.e., B.Com. that provides knowledge in Commerce and Business. So if you want to pursue education based on a specific industry or profession the Bachelor of Management.

Helps in Overall Personality Development

Pursuing a bachelor's degree can be one of the most exhilarating experiences, in fact, you have just started your journey in this competitive world and a bachelor's of commerce (B. Com) helps you face the world right after school. But a Master in Business Administration prepares you to suit yourself to the industry's needs. The curriculum is carefully crafted and includes workshops, seminars, projects, etc. that develops your overall personality.

Vast Career choice

There are so many courses available for B.Com. Students such as M.Com., MBA, CA (Chartered Accountant), CS (Company Secretary), MCA and many of the diploma courses, etc. After completion of Bachelor in Commerce, an individual has the option to pursue higher studies as M-Com (Masters of Commerce) or MBA (Masters in Business Administration), both being postgraduate program focusing in Commerce, Accounting, Economics, and Management related subjects. Not only this Bachelor program also prepares students for CA (Chartered Accountant), CS (Company Secretary) and CMA (Cost and Management Accountant) as an advance career option in this field.

At the End of the whole syllabus any remarks/ suggestions:

The whole syllabus of Undergraduate Commerce is divided into three parts. After first year (two semesters) completion the certificate awarded is called C.Com. (Certificate in Commerce), after two year (four semester) completion the diploma awarded is called D.Com. (Diploma in Commerce) and after three year (six semester) completion the bachelor degree of commerce awarded is called B. Com. (Bachelor of Commerce).

::SUBJECT PREREQUISITES::

To study this subject, a student must have had the subjects Physics & Mathematics in class 12th

::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.

::PROGRAMME SPECIFIC OUTCOMES (PSOs)::

After completing B.Sc. (with physics) the student should have

CERTIFICATE

IN BASIC PHYSICS & SEMICONDUCTOR DEVICES

After completing this certificate course, the student should have

- *Competence in the methods and techniques of calculations using Newtonian Mechanics and Thermodynamics.*
- *Students are expected to have hands on experience in modeling, implementation and calculation of physical quantities of relevance.*
- *Students are expected to have an insight in handling electrical and electronic instruments.*
- *Student should be able to handle basic electronic instruments, which are being used in electronics, telecommunication and instrumentation industry.*

DIPLOMA

IN APPLIED PHYSICS WITH ELECTRONICS

After completing this diploma course, the student should have

- *Knowledge of different concepts in electromagnetic theory, Modern Optics and Relativistic Mechanics.*
- *Knowledge of electromagnetic wave propagation, which serves as a basis for all communication systems and deals with the physics and technology of semiconductor optoelectronic devices.*
- *A deeper insight in electronics to address the important components in consumer Optoelectronics, IT and communication devices, and in industrial instrumentation.*
- *Knowledge of basic concepts of optical instruments and lasers with their applications in technology.*

DEGREE

IN BACHELOR OF SCIENCE

After completing this degree course, the student should have

- *Knowledge of different aspects of classical, quantum and statistical computational tools required in the calculation of physical quantities of relevance in interacting many body problems in physics.*
- *Develop the basic knowledge and proficiency of solid-state physics and nuclear physics, which have utmost importance at both undergraduate and graduate level.*
- *Proficiency in this area will attract demand in research and industrial establishments engaged in activities involving applications of these fields.*
- *Comprehensive knowledge of Analog & Digital Principles and Applications.*
- *Learn the integrated approach to analog electronic circuitry and digital electronics for R&D.*

Programme Class: **Certificate**	Year: **First**	Semester: **First**
Subject: **PHYSICS**		
Course Code: **(B010101T)**	Course title: **Mathematical Physics & Newtonian Mechanics**	

Course Outcomes:

- Recognize the difference between scalars, vectors, pseudo-scalars and pseudo-vectors.
- Understand the physical interpretation of gradient, divergence and curl.
- Comprehend the difference and connection between Cartesian, spherical and cylindrical coordinate systems.
- Know the meaning of 4-vectors, Kronecker delta and Epsilon (Levi Civita) tensors.
- Study the origin of pseudo forces in rotating frame.
- Study the response of the classical systems to external forces and their elastic deformation.
- Understand the dynamics of planetary motion and the working of Global Positioning System (GPS).
- Comprehend the different features of Simple Harmonic Motion (SHM) and wave propagation.

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**

Unit	**Topics**	**No. of Lectures**
	Part A: Basic Mathematical Physics	
	Contribution of Indian Scientists: Contributions of Aryabhata, Vikram Sarabhai, C V Raman, S N Bose, M N Shaha, Subrahmanyam, Chandrasekhar.	
I	**Vector Algebra** Coordinate rotation, reflection and inversion for defining scalars, vectors, pseudo-scalars and pseudo-vectors (include physical examples). Component form in 2D and 3D. Geometrical and physical interpretation of addition, subtraction, dot product, wedge product, cross product and triple product of vectors. Position, separation and displacement vectors.	7
II	**Vector Calculus:** Geometrical and physical interpretation of vector differentiation, Gradient, Divergence and Curl and their significance. Vector integration, Line, Surface (flux) and Volume integrals of vector fields. Gradient theorem, Gauss-divergence theorem, Stoke-curl theorem, Green's theorem (statement only). Introduction to Dirac delta function.	8
III	**Coordinate Systems:** 2D & 3D Cartesian, Spherical and Cylindrical coordinate systems, basis vectors, transformation equations. Expressions for displacement vector, arc length, area element, volume element, gradient, divergence and curl in different coordinate systems. Components of velocity and acceleration in different coordinate systems.	8
IV	**Introduction to Tensors** Principle of invariance of physical laws w.r.t. different coordinate systems as the basis for defining tensors. contravariant, covariant & mixed tensors and their ranks, 4-vectors. Index notation and summation convention. Symmetric and skew-symmetric tensors. Examples of tensors in physics.	7

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

Quiz/ Assignment	**(05 marks)**
Class Test-I	**(10 marks)**
Class Test-II	**(10 marks)**

- The course can be opted as an elective, which is open to all students.
- **PREREQUISITE:** Physics and Mathematics in 12th

Programme Class: **Certificate**	Year: **First**	Semester: **First**
Subject: **PHYSICS**		
Course Code: **(B010102P)**	Course Title: **Mechanical Properties of Matter**	

Course Outcome:

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

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: 0-**0-4**

Unit	**Topics**	**No. of Lectures**
	Lab Experiment List	
	1. Moment of inertia of a flywheel 2. Moment of inertia of an irregular body by inertia table 3. Modulus of rigidity by statistical method (Barton's apparatus) 4. Modulus of rigidity by dynamical method (sphere / disc / Maxwell's needle) 5. Young's modulus by bending of beam 6. Young's modulus and Poisson's ratio by Searle's method 7. Poisson's ratio of rubber-by-rubber tubing 8. Surface tension of water by capillary rise method 9. Surface tension of water by Jaeger's method 10. Coefficient of viscosity of water by Poiseuille's method 11. Acceleration due to gravity by bar pendulum 12. Frequency of AC mains by Sonometer 13. Height of a building by Sextant **14.** Study the wave form of an electrically maintained tuning fork / alternating current source with the help of cathode ray oscilloscope.	60

Programme Class: **Certificate**	Year: **First**	Semester: **Second**
Subject: **PHYSICS**		
Course Code: **(B010201T)**	Course title: **Thermal Physics & Semiconductor Devices**	

Course Outcomes:

- Recognize the difference between reversible and irreversible processes.
- Understand the physical significance of thermodynamical potentials.
- Comprehend the kinetic model of gases w.r.t. various gas laws.
- Study the implementations and limitations of fundamental radiation laws.
- Utility of AC bridges.
- Recognize the basic components of electronic devices.
- Design simple electronic circuits.
- Understand the applications of various electronic instruments.

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**

Unit	Topics	No. of Lectures
	Part A: Thermodynamics & Kinetic Theory of Gases	
I	**0^{th} & 1^{st} Law of Thermodynamics:** State functions and terminology of thermodynamics. Zeroth law and temperature. First law, internal energy, heat and work done. Work done in various thermodynamical processes. Enthalpy, relation between C_P and C_V. Carnot's engine, efficiency and Carnot's theorem. Efficiency of internal combustion engines (Otto and diesel).	8
II	**2^{nd} & 3^{rd} Law of Thermodynamics:** Different statements of second law, Clausius inequality, entropy and its physical significance. Entropy changes in various thermodynamical processes. Third law of thermodynamics and unattainability of absolute zero. Thermodynamical potentials, Maxwell's relations, conditions for feasibility of a process and equilibrium of a system. Clausius- Clapeyron equation, Joule-Thompson effect.	8
III	**Kinetic Theory of Gases:** Kinetic model and deduction of gas laws. Derivation of Maxwell's law of distribution of velocities and its experimental verification. Degrees of freedom, law of equipartition of energy (no derivation) and its application to specific heat of gases (mono, di and poly atomic).	7
IV	**Theory of Radiation:** Blackbody radiation, spectral distribution, concept of energy density and pressure of radiation. Derivation of Planck's law, deduction of Wien's distribution law, Rayleigh-Jeans law, Stefan-Boltzmann law and Wien's displacement law from Planck's law.	7
	PART B: Circuit Fundamentals & Semiconductor Devices	
V	**DC & AC Circuits:** Growth and decay of currents in RL circuit. Charging and discharging of capacitor in RC, LC and RCL circuits. Network Analysis - Superposition, Reciprocity, Thevenin's and Norton's theorems. AC	7

- National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
- Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
- Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

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

Quiz/ Assignment	**(05 marks)**
Class Test-I	**(10 marks)**
Class Test-II	**(10 marks)**

- The course is elective and can be opted as an elective, which is open to all students.
- **PREREQUISITE:** Physics in 12^{th} / Chemistry in 12^{th}

Programme Class: **Certificate**	Year: **First**	Semester: **Second**
Subject: **PHYSICS**		
Course Code: **(B010202P)**	Course Title: **Thermal Properties of Matter & Electronic Circuits**	
Course Outcomes: Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the thermal and electronic properties. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.		
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: 0-**0-4**		
Unit	**Topics**	**No. of Lectures**
	Lab Experiment List	
	1. Mechanical Equivalent of Heat by Callender and Barne's method 2. Coefficient of thermal conductivity of copper by Searle's apparatus 3. Coefficient of thermal conductivity of rubber 4. Coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method 5. Value of Stefan's constant 6. Verification of Stefan's law 7. Variation of thermo-emf across two junctions of a thermocouple with temperature 8. Temperature coefficient of resistance by Platinum resistance thermometer 9. Charging and discharging in RC and RCL circuits 10. A.C. Bridges: Various experiments based on measurement of L and	60

Record File	**(15 marks)**
Viva Voce	**(05 marks)**
Class Interaction	**(10 marks)**

- The course is elective and can be opted by Botany / Chemistry / Computer Science / Mathematics / Statistics / Zoology
- **PREREQUISITE:** Opted / Passed Semester II, Theory Paper-1 (B010201T)

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.
- The institution may suggest a minimum number of experiments (say 3) to be performed by each student per semester from the Online Virtual Lab Experiment List / Link.

Programme Class: **Diploma**	Year: **Second**	Semester: **Third**
Subject: **PHYSICS**		
Course Code: **(B010301T)**	Course title: **Electromagnetic Theory & Modern Optics**	

Course Outcome:

- Better understanding of electrical and magnetic phenomenon in daily life.
- To troubleshoot simple problems related to electrical devices.
- Comprehend the powerful applications of ballistic galvanometer.
- Study the fundamental physics behind reflection and refraction of light (electromagnetic waves).
- Study the working and applications of Michelson and Fabry-Perot interferometers.
- Recognize the difference between Fresnel's and Fraunhofer's class of diffraction.
- Comprehend the use of polarimeters.
- Study the characteristics and uses of lasers.

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**	

Unit	**Topics**	**No. of Lectures**
	Part A: Electromagnetic Theory	
I	**Electrostatics:** Electric charge & charge densities, electric force between two charges. General expression for Electric field in terms of volume charge density (divergence & curl of Electric field), general expression for Electric potential in terms of volume charge density and Gauss law (applications included). Study of electric dipole. Electric fields in matter, polarization, auxiliary field **D** (Electric displacement), electric susceptibility and permittivity.	8
II	**Magnetostatics:**	

Suggested Readings:

PART A

1. H. K. Malik and A.K. Singh "Engineering Physics", McGraw Hill Education (India) Private Limited, 2018, 2e.
2. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 2", Pearson Education Limited, 2012
3. D. J. Griffiths, "Introduction to Electrodynamics", Prentice-Hall of India Private Limited, 2002, 3e
4. E. M. Purcell, "Electricity and Magnetism (In SI Units): Berkeley Physics Course Vol 2", McGraw Hill, 2017, 2e
5. D.C. Tayal, "Electricity and Magnetism", Himalaya Publishing House Pvt. Ltd., 2019, 4e

PART B

6. H. K. Malik, "Engineering Physics", McGraw Hill Education (India) Private Limited, 2018, 2e.
7. Francis A. Jenkins, Harvey E. White, "Fundamentals of Optics", McGraw Hill, 2017, 4e
8. Samuel Tolansky, "An Introduction to Interferometry", John Wiley & Sons Inc., 1973, 2e
9. A. Ghatak, "Optics", McGraw Hill, 2017, 6e

Local Author's Books

1. Optics, Brij Lal and Subrahmanyam, S. Chand Publication.
2. Physical Optics and Lasers, Agarwal, Jain & Sharma, Krishna Prakashan.
3. भौतिक प्रकाशिकी व लेजर, अग्रवाल, जैन व शर्मा, कृष्णा प्रकाशन ।

Suggestive Digital Platforms / Web Links:

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. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
   Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Suggested Continuous Internal Evaluation Methods:

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

Quiz/ Assignment	**(05 marks)**
Class Test-I	**(10 marks)**
Class Test-II	**(10 marks)**

- The course is elective and open to all.
- **PREREQUISITE:** passed semester I, theory paper-1 (B010101T)

Programme Class: **Diploma**	Year: **Second**	Semester: **Third**
Subject: **PHYSICS**		
Course Code: **(B010302P)**	Course Title: **Demonstrative Aspects of Electricity & Magnetism**	

Course Outcome:

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

Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.		
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: 0-**0-4**		
Unit	**Topics**	**No. of Lectures**
Lab Experiment List		
	1. Variation of magnetic field along the axis of single coil 2. Variation of magnetic field along the axis of Helmholtz coil 3. Ballistic Galvanometer: Ballistic constant, current sensitivity and voltage sensitivity 4. Ballistic Galvanometer: High resistance by Leakage method 5. Ballistic Galvanometer: Low resistance by Kelvin's double bridge method 6. Ballistic Galvanometer: Self-inductance of a coil by Rayleigh's method 7. Ballistic Galvanometer: Comparison of capacitances 8. Carey Foster Bridge: Resistance per unit length and low resistance 9. Deflection and Vibration Magnetometer: Magnetic moment of a magnet and horizontal component of earth's magnetic field 10. Earth Inductor: Horizontal component of earth's magnetic field 11. Newton's Rings: Wavelength of sodium light 12. Plane Diffraction Grating: Spectrum of mercury light 13. Spectrometer: Refractive index of the material of a prism using sodium light 14. Spectrometer: Dispersive power of the material of a prism using mercury light 15. Polarimeter: Specific rotation of sugar solution	60
	Online Virtual Lab Experiment List/Link	
	Virtual Labs at Amrita Vishwa Vidyapeetham https://vlab.amrita.edu/?sub=1&brch=192 1. Tangent galvanometer 2. Magnetic field along the axis of a circular coil carrying current 3. Deflection magnetometer 4. Van de Graaff generator 5. Barkhausen effect 6. Temperature coefficient of resistance 7. Anderson's bridge 8. Quincke's method	

Suggested Readings:

1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1e
3. R.K. Agrawal, G. Jain, R. Sharma, "Practical Physics", Krishna Prakashan Media (Pvt.) Ltd., Meerut, 2019
4. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014, 2e

Suggestive Digital Platforms / Web Links:

- Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=192
- 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)**
Viva Voce	**(05 marks)**
Class Interaction	**(10 marks)**

- The course is elective and can be opted by Botany / Chemistry / Computer Science / Mathematics / Statistics / Zoology
- **PREREQUISITE:** Opted / Passed Semester III, Theory Paper-1 (B010301T)

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.
- The institution may suggest a minimum number of experiments (say 3) to be performed by each student per semester from the Online Virtual Lab Experiment List / Link.

Programme Class: **Diploma**	Year: **Second**	Semester: **Fourth**
Subject: **PHYSICS**		
Course Code: **(B010401T)**	Course title: **Perspectives of Modern Physics & Basic Electronics**	

Course Outcomes:

- Recognize the difference between the structure of space & time in Newtonian & Relativistic mechanics.
- Understand the physical significance of consequences of Lorentz transformation equations.
- Comprehend the wave-particle duality.
- Develop an understanding of the foundational aspects of Quantum Mechanics.
- Study the comparison between various biasing techniques.
- Study the classification of amplifiers.
- Comprehend the use of feedback and oscillators.
- Comprehend the theory and working of optical fibers along with its applications.

Credits: **4**	Core Compulsory / Elective

19. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
20. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

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

Quiz/ Assignment	**(05 marks)**
Class Test-I	**(10 marks)**
Class Test-II	**(10 marks)**

- The course is elective and open to all.
- **PREREQUISITE:** Passed Semester I, Theory Paper-1 (B010101T)

Programme Class: **Diploma**	Year: **Second**	Semester: **Fourth**
Subject: **PHYSICS**		
Course Code: **(B010402P)**	Course Title: **Basic Electronics Instrumentation**	

Course Outcomes:
Basic Electronics instrumentation has the most striking impact on the industry wherever the components / instruments are used to study and determine the electronic properties. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

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: 0-**0-4**		
Unit	**Topics**	**No. of Lectures**
	Lab Experiment List	
	1. Transistor Bias Stability 2. Comparative Study of CE, CB and CC amplifier 3. Clippers and Clampers 4. Study of Emitter Follower 5. Frequency response of single stage RC coupled amplifier 6. Frequency response of single stage Transformer coupled amplifier 7. Effect of negative feedback on frequency response of RC coupled amplifier 8. Study of Schmitt Trigger 9. Study of Hartley oscillator **10.** Study of Wein Bridge oscillator	60
	Online Virtual Lab Experiment List/Link	
	Virtual Labs an initiative of MHRD Govt. of India http://vlabs.iitkgp.ac.in/psac/#	

- The institution may suggest a minimum number of experiments (say 6) to be performed by each student per semester from the Lab Experiment List.
- The institution may suggest a minimum number of experiments (say 3) to be performed by each student per semester from the Online Virtual Lab Experiment List / Link.

Programme Class: **Degree**	Year: **Third**	Semester: **Fifth**
Subject: **PHYSICS**		
Course Code: **(B010501T)**	Course title: **Classical & Statistical Mechanics**	

Course Outcomes:

1. Understand the concepts of generalized coordinates and D'Alembert's principle.
2. Understand the Lagrangian dynamics and the importance of cyclic coordinates.
3. Comprehend the difference between Lagrangian and Hamiltonian dynamics.
4. Study the important features of central force and its application in Kepler's problem.
5. Recognize the difference between macrostate and microstate.
6. Comprehend the concept of ensembles.
7. Understand the classical and quantum statistical distribution laws.
8. Study the applications of statistical distribution laws.

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**

Unit	**Topics**	**No. of Lectures**
	Part A: Introduction to Classical Mechanics	
I	**Constrained Motion:** Constraints - Definition, Classification and Examples. Degrees of Freedom and Configuration space. Constrained system, Forces of constraint and Constrained motion. Generalised coordinates, Transformation equations and Generalised notations & relations. Principle of Virtual work and D'Alembert's principle.	6
II	**Lagrangian Formalism:** Lagrangian for conservative & non-conservative systems, Lagrange's equation of motion (no derivation), Comparison of Newtonian & Lagrangian formulations, Cyclic coordinates, and Conservation laws (with proofs and properties of kinetic energy function included). Simple examples based on Lagrangian formulation.	9
III	**Hamiltonian Formalism:** Phase space, Hamiltonian for conservative & non-conservative systems, Physical significance of Hamiltonian, Hamilton's equation of motion (no derivation), Comparison of Lagrangian & Hamiltonian formulations, Cyclic coordinates, and Construction of Hamiltonian from Lagrangian. Simple examples based on Hamiltonian formulation.	8
IV		7

Quiz/ Assignment	(05 marks)
Class Test-I	(10 marks)
Class Test-II	(10 marks)

- This course can be opted as an Elective by the students of Chemistry / Computer Science / Mathematics / Statistics
- **PREREQUISITE:** Passed Semester I, Theory Paper-1 (B010101T)

Programme Class: **Degree**	Year: **Third**	Semester: **Fifth**
Subject: **PHYSICS**		
Course Code: **(B010502T)**	Course title: **Quantum Mechanics & Spectroscopy**	

Course Outcome:

1. Understand the significance of operator formalism in Quantum mechanics.
2. Study the eigen and expectation value methods.
3. Understand the basis and interpretation of Uncertainty principle.
4. Develop the technique of solving Schrodinger equation for 1D and 3D problems.
5. Comprehend the success of Vector atomic model in the theory of Atomic spectra.
6. Study the different aspects of spectra of Group I & II elements.
7. Study the production and applications of X-rays.
8. Develop an understanding of the fundamental aspects of Molecular spectra.

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**

Unit	Topics	No. of Lectures
	Part A: Introduction to Quantum Mechanics	
I	**Formulation of quantum mechanics & Operators** Basic idea about particle aspect of radiation, wave aspect of particles and wave particle duality; Double slit experiment, Probabilistic interpretation, wave packet, observables and operators, Hermitian operator (Definition, Proof, properties), commutative and simultaneous operators, Wave function, Orthonormalization condition of wave function, Swartz inequality. Review of matrix algebra, definition of an operator, special operators, operator algebra and operators.	6
II	**Eigen & Expectation Values and Uncertainty Principle:** Eigen & Expectation Values: Eigen equation for an operator, eigen state (value) and eigen functions. Linear superposition of eigen functions and Non-degenerate & Degenerate eigen states. Expectation value pertaining to an operator and its physical interpretation.	6

Suggested Readings:

PART A

1. D.J. Griffiths, "Introduction to Quantum Mechanics", Pearson Education, India, 2004, 2e
2. H. K. Malik and A.K. Singh "Engineering Physics", McGraw Hill Education (India) Private Limited, 2018, 2e.
3. N. Zettili, "Quantum Mechanics, Concepts and Applications", ohn Wiley and Sons, Ltd., Publication 2009.
4. E. Wichmann, "Quantum Physics (In SI Units): Berkeley Physics Course Vol 4", McGraw Hill, 2017
5. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 3", Pearson Education Limited, 2012
6. R Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e

PART B

7. H.E. White, "Introduction to Atomic Spectra", McGraw Hill, 1934
8. C.N. Banwell, E.M. McCash, "Fundamentals of Molecular Spectroscopy", McGraw Hill, 2017, 4e
9. R Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e
10. S.L. Gupta, V. Kumar, R.C. Sharma, "Elements of Spectroscopy", Pragati Prakashan, Meerut, 2015, 27e

Local Author's Books

1. Refresher Course in Physics; Vol-II, C.L. Arora, S. Chand Publication.
2. Optics & Spectroscopy, Kiruthiga Sivaprasath, S. Chand Publication.
3. Quantum Mechanics, Kamal Singh & S.P. Singh, S. Chand Publication.
4. Elements of Quantum Mechanics, Agarwal, Jain & Sharma, Krishna Prakashan.
5. क्वाण्टम यांत्रिकी के अवयव, अग्रवाल, जैन व शर्मा, कृष्णा प्रकाशन ।

Suggestive Digital Platforms / Web Links:

11. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
12. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
13. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
14. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Suggested Continuous Evaluation Methods:

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

Quiz/ Assignment	**(05 marks)**
Class Test-I	**(10 marks)**
Class Test-II	**(10 marks)**

- This course can be opted as an Elective by the students of Chemistry / Computer Science / Mathematics / Statistics
- **PREREQUISITE:** Passed Semester IV, Theory Paper-1 (B010401T)

Suggested Readings:

1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1e
3. R.K. Agrawal, G. Jain, R. Sharma, "Practical Physics", Krishna Prakashan Media (Pvt.) Ltd., Meerut, 2019
4. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014, 2e

Suggestive Digital Platforms / Web Links:

1. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=189
2. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/index.php?sub=1&brch=281
3. 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)**
Viva Voce	**(05 marks)**
Class Interaction	**(10 marks)**

- This course can be opted as an Elective by the students of Chemistry / Computer Science / Mathematics / Statistics
- **PREREQUISITE:** Passed Semester III, Theory Paper-1 (B010301T)

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.
- The institution may suggest a minimum number of experiments (say 3) to be performed by each student per semester from the Online Virtual Lab Experiment List / Link.

Programme Class: **Degree**	Year: **Third**	Semester: **Sixth**
Subject: **PHYSICS**		
Course Code: **(B010601T)**	Course title: **Solid State & Nuclear Physics**	

Course Outcomes:

1. Understand the crystal geometry w.r.t. symmetry operations.
2. Comprehend the power of X-ray diffraction and the concept of reciprocal lattice.
3. Study various properties based on crystal bindings.
4. Recognize the importance of Free Electron & Band theories in understanding the crystal properties.
5. Study the salient features of nuclear forces & radioactive decays.
6. Understand the importance of nuclear models & nuclear reactions.
7. Comprehend the working and applications of nuclear accelerators and detectors.
8. Understand the classification and properties of basic building blocks of nature.

Credits: **4**	Core Compulsory / Elective

Programme Class: **Degree**	Year: **Third**	Semester: **Sixth**
Subject: **PHYSICS**		
Course Code: **(B010602T)**	Course title: **Analog & Digital Principles & Applications**	
Course Outcomes: 1. Study the drift and diffusion of charge carriers in a semiconductor. 2. Understand the Two-Port model of a transistor. 3. Study the working, properties and uses of FETs. 4. Comprehend the design and operations of SCRs and UJTs. 5. Understand various number systems and binary codes. 6. Familiarize with binary arithmetic. 7. Study the working and properties of various logic gates. 8. Comprehend the design of combinational and sequential circuits.		
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**		
Unit	**Topics**	**No. of Lectures**
Part A: Analog Electronic Circuits		
I	**Semiconductor Junction:** Expressions for Fermi energy, Electron density in conduction band, Hole density in valence band, Drift of charge carriers (mobility & conductivity), Diffusion of charge carries and Life time of charge carries in a semiconductor. Work function in metals and semiconductors. Expressions for Barrier potential, Barrier width and Junction capacitance (diffusion & transition) for depletion layer in a PN junction. Expressions for Current (diode equation) and Dynamic resistance for PN junction.	9
II	**Transistor Modeling:** Transistor as Two-Port Network. Notation for dc & ac components of voltage & current. Quantitative discussion of Z, Y & h parameters and their equivalent two-generator model circuits. h-parameters for CB, CE & CC configurations. Analysis of transistor amplifier using the hybrid equivalent model and estimation of Input Impedance, Output Impedance and Gain (current, voltage & power).	8
III	**Field Effect Transistors:** JFET: Construction (N channel & P channel); Configuration (CS, CD & CG); Operation in different regions (Ohmic or Linear, Saturated or Active or Pinch off & Break down); Important Terms (Shorted Gate Drain Current, Pinch Off Voltage & Gate Source Cut-Off Voltage); Expression for Drain Current (Shockley equation); Characteristics (Drain & Transfer); Parameters (Drain Resistance, Mutual Conductance or Transconductance & Amplification Factor); Biasing w.r.t. CS	8

Suggested Readings:

PART A

1. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
2. J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
3. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
4. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
5. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e

PART B

1. D. Leach, A. Malvino, Goutam Saha, "Digital Principles and Applications", McGraw Hill, 2010, 7e
2. William H. Gothmann, "Digital Electronics: An Introduction to Theory and Practice", Prentice-Hall of India Private Limited, 1982, 2e
3. R.P. Jain, "Modern Digital Electronics", McGraw Hill, 2009, 4e

Suggestive Digital Platforms / Web Links:

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. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
4. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Suggested Continuous Evaluation Methods:

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

Quiz/ Assignment	**(05 marks)**
Class Test-I	**(10 marks)**
Class Test-II	**(10 marks)**

- The course is elective and open to all.
- **PREREQUISITE:** Passed Semester IV, Theory Paper-1 (B010401T)

Programme Class: **Degree**	Year: **Third**	Semester: **Sixth**
Subject: **PHYSICS**		
Course Code: **(B010603P)**	Course Title: **Analog & Digital Circuits**	

Course Outcomes:

Analog & digital circuits have the most striking impact on the industry wherever the electronics instruments are used to study and determine the electronic properties. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

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: 0-**0-4**	

Open Elective Courses for UG Program as an Optional

(To be taught in First/ Third /Odd Semester)

Course prerequisites:
This course can be opted as a minor elective by the students. Open to all.

Syllabus of the course

Programme Class:	Year	Semester
Subject: **PHYSICS**		
Course Code: **(B010103T)**	Course Title: **Earth's Atmosphere and Climate Change**	

Course Outcomes:

After completing this course, a student will have:

- Knowledge of basic structure and composition of the Earth
- Knowledge of various atmospheric characterization parameters and their variation in the atmosphere.
- Inculcate the understanding of structure, atmosphere and energy release phenomenon of the sun.
- Knowledge of anthropogenic intervention in 'anthropocene', which has led to global climate change.
- Knowledge about effects of global changes on human communities
- Idea about initiatives taken at global and regional levels to combat them.

Credits: 04	Core: **Minor Elective**
Max. Marks: **25+75**	Min. Passing Marks: ……

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

Unit	**Topic**	**No. of Lectures**
	PART A: Sun and Earth Atmosphere	
I	**Overview of Earth's Atmosphere:** Origin of the Atmosphere, Composition of the Atmosphere; major components (nitrogen, oxygen and argon), minor components, water vapor, aerosols and ozone, Homosphere and Heterosphere, Vertical structure of the atmosphere; air density, air pressure, air temperature, temperature scales, Temperature profile of earth's atmosphere, Vertical distribution of air pressure, Horizontal distribution of air pressure, Equation of state, Ideal gas law, Hydrostatic balance, Layers of the atmosphere; troposphere, atmospheric boundary layer, stratosphere, mesosphere, thermosphere.	13

Programmeoutcomes(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 pedagogicaltrends in education including e-learning, flipped class and hybrid learning to develop into responsiblecitizen for nation-building and transforming the country towards the future with their knowledge gainedinthefield of plant science.

PO1	CBCSsyllabuswithacombinationofgeneralandspecializededucationshallintroducethe conceptsofbreadthand depthin learning
PO2	Shallproducecompetentplantbiologistswhocanemployandimplementtheirgainedknowledgein basicandappliedaspectsthatwillprofoundlyinfluencetheprevailingparadigm ofagriculture,industry,healthcareandenvironmenttoprovidesustainabledevelopment.
PO3	Will increase the ability of critical thinking, development of scientific attitude, handling ofproblems and generating solutions, improve practical skills, enhance communication skill,socialinteraction,increaseawarenessinjudicioususeofplantresourcesbyrecognizingthe ethicalvaluesystem.
PO4	The training provided to the students will make them competent enough for doing jobs inGovt. and private sectors of academia, research and industry along with graduate preparationfornationalaswellasinternationalcompetitiveexaminations,especiallyUGC-CSIRNET, UPSCCivilServicesExamination, IFS,NSC,FCI,BSI,FRIetc.
PO5	Certificateanddiplomacoursesareframedtogenerateself-entrepreneurshipandself-employability,ifmultiexitoptionis opted.
PO6	Lifelonglearning be achieved bydrawingattention tothevast world ofknowledgeofplants andtheirdomestication.

Programmespecificoutcomes(PSOs):

B.Sc.IYear/CertificatecourseinMicrobialTechnology&ClassicalBotany

This Programme imparts knowledge on various fields of plant biology through teaching, interactions andpracticalclasses.Itshallmaintainabalancebetweenthetraditionalbotanyandmodernscienceforshiftingit towards the frontier areas of plant sciences with applied approach. This syllabus has been drafted toenable the learners to prepare them for self-entrepreneurship and employment in various fields includingacademicsaswell ascompetitive exams.Students wouldgain wideknowledgeinfollowingaspects:

1. Diversityofplantsandmicrobes,theirhabitat,morphology,architecture andreproduction.

2. Plantdiseasecausingmicrobes,symptoms&control.

3. Economicvalueofplantsand theirusein HumanWelfare.

Programmespecificoutcomes(PSOs):

B.Sc.IIYear/(Diplomain PlantIdentification,Utilization&Ethnomedicine)

This course provides a broad understanding of identifying, growing and using plants. This course isprimarily aimed to introduce people to the richness of plant diversity found in surrounding areas. Lecturesessions are designed to cover fundamental topics concerning classification of plants and their utilizationrequired for understanding the flora and vegetation. Practical sessions are organized following theory foreasy understanding of the various parts of the plants, structural organization of floral parts and diversitytherein.Participantsaretakentodifferentlocationscoveringavarietyofhabitatsandforesttypesto acquaintthemwiththenativeflora.inthelongrun,willcontributetowardsbuildingmomentumfor

people'sparticipationinenvironmentalconservationwithoutcompromisingonacademicrigorandourrichwealth of knowledgeinherited overgenerations.

1. Thecourse will coverconventional topics in FieldBotanylikeEvolutionaryHistory&Diversityofplants, Complete Morphology, Nomenclature of plants, Systems of Classification, Keys toimportantFamilies of FloweringPlants,FieldDataCollection &Herbarium Techniques.

2. Thecourseisdesignedtobecome acommercialcrop grower, florist,protectedcultivator,greenbeltplant advisor to industries, pharmacologist &taxonomist.

Programmespecificoutcomes (PSOs):
B.Sc.III Year/Bachelorof Science

The learning outcomesof a threeyears graduation course are alignedwith programme learningoutcomes but these are specific to-specific courses offered in a program. The core courses shall be thebackbone of this framework whereas discipline electives, generic electives and skill enhancementcourseswouldaddacademicexcellenceinthesubjecttogetherwithamulti-dimensionalandmultidisciplinaryapproach.

1. Understandingofplantclassificationsystematics,evolution,ecology,developmentalbiology,physiology,biochemistry,plantinteractionswithmicrobesandinsects,morphology,anatomy,reproduction,genetics and molecularbiologyof various life-forms.

2. Thiscourseissuitabletoproduceexpertiseinconservationbiologylikeex-situconservation,responseto habitat change,genotypecharacterization and reproductivebiology.

3.Understanding of various analytical techniques of plant sciences, use of plants as industrial resourcesor as a human livelihood support system and is well versed with the use of transgenic technologies forbasicand appliedresearch in plants.

4. Understandingofvariouslifeformsofplants,morphology,anatomy,reproduction,genetics,microbiology, molecular biology, recombinant DNA technology, transgenic technology and use ofbioinformaticstools and databasesand the application ofstatistics to biological data.

5. EntrepreneurshipSkillDevelopment,Understandtheissuesofenvironmentalcontextsandsustainabledevelopment,Inculcation ofhuman values,

6. Strengthenmathematicalandcomputationalskills.Enablestudentstouse ICT&AIeffectively.

7. Develop good skills in the laboratory such as observation and evaluation by the use of modern toolsandtechnology.

PSO1	Understanding the nature and basicconcepts of all the plantgroups, their metabolism,componentsat themolecularlevel, biochemistry,taxonomyandecology. Thecoursewillmakethemawareofnaturalresourcesandtheenvironmentandtheimportanceof conserving it. Hands-on training in various fields will develop practical skills, handlingequipment and laboratory use along with collection and interpretation of biological materialsand data. Knowledge gained through theoretical and lab-based experiments will generatetechnicalpersonnelinvariousprioritysareassuchasgenetics,cellandmolecularbiology,plantsystematicsand biotechnology.

CERTIFICATECOURSEINMICROBIALTECHNOLOGY&CLASSICALBOTANY/B.Sc.-I		
Programme: *CertificateCourseinMicrobialTechnology&ClassicalBotany*	Year: I	Semester: **I/Paper-I**
Subject:**Botany**		
CourseCode: B040101T	CourseTitle:**Microbiology&Plant Pathology**	

Courseoutcomes: Afterthecompletionofthecoursethestudents willbeableto:

1. Developunderstanding abouttheclassificationanddiversityof differentmicrobesincludingviruses,Algae,Fungi&Lichens&their economic importance.
2. Developconceptualskillaboutidentifyingmicrobes,pathogens,biofertilizers&lichens.
3. Gainknowledgeaboutdevelopingcommercialenterpriseofmicrobialproducts.
4. Learnhost–pathogenrelationshipanddiseasemanagement.
5. LearnPresentationskills(oral&writing)inlifesciencesbyusageofcomputer&multimedia.
6. GainKnowledgeabout usesofmicrobesinvariousfields.
7. Understandthestructureandreproductionofcertainselectedbacteriaalgae,fungiandlichens
8. GainKnowledgeabouttheeconomicvaluesofthislowergroupofplantcommunity.

Credits:**4**	**CoreCompulsory**
Max.Marks: **25+75**	Min.PassingMarks:
TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**4-0-0**	

Unit	Topic	No.of Lectures(60 hrs)

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector SkillCouncils / Diploma holder from ITI in (Biology/ Agriculture/ Biotech/ Forestry/ Microbiology/Gardening /biomedicalScience.

Facilities:SmartandInteractiveClass

OtherRequisites: Videocollection,Books,CDs,AccesstoOn-lineresources,DisplayCharts

Suggested equivalent online courses:https://indianculture.gov.in/rarebooks/economic-botany-indiahttps://community.plantae.org/tags/mooc futurelearn.com/courses/teaching-biology-inspiring-students-with-plants-in-sciencehttps://www.coursera.org/courses?query=plantshttp://egyankosh.ac.in/handle/123456789/53530https://www.classcentral.com/tag/microbiologyhttps://www.edx.org/learn/microbiology https://www.mooc-list.com/tags/microbiologyhttps://www.udemy.com/topic/microbiology/https://ucmp.berkeley.edu/bacteria/bacteria.htmlhttps://www.livescience.com/53272-what-is-a-virus.htmlhttps://gclambathach.in/lms/Economic%20importance%20of%20Algae.pdfhttps://www.slideshare.net/sardar1109/algae-notes-1https://www.onlinebiologynotes.com/algae-general-characteristics-classification/https://www.sciencedirect.com/topics/immunology-and-microbiology/fungushttps://ucmp.berkeley.edu/fungi/fungi.html https://agrimoon.com/wp-content/uploads/Mashroom-culture.pdfhttp://ecoursesonline.iasri.res.in/mod/page/view.php?id=11293http://www.hillagric.ac.in/edu/coa/ppath/lect/plpath111/Lect.%201%20%20Introduction-Pl%20Path%20111.pdfhttp://www.jnkvv.org/PDF/11042020102651plant_pathology.pdfhttps://www.apsnet.org/edcenter/disimpactmngmnt/topc/EpidemiologyTemporal/Pages/ManagementStrategies.aspxhttps://learn.saylor.org/course/view.php?id=23&sectionid=6821 https://www.sciencedirect.com/topics/earth-and-planetary-sciences/microscopyhttp://physics.fe.uni-lj.si/students/predavanja/Microscopy_Kulkarni.pdfhttps://lipidnanostructuresgroup.weebly.com/https://zoology4civilservices.wordpress.com/2016/06/18/65/https://microbenotes.com/laminar-flow-hood/

CERTIFICATECOURSEINMICROBIALTECHNOLOGY &CLASSICALBOTANY/B.Sc.-I

Programme:*CertificateCourseinMicrobialTechnology&ClassicalBotany*	Year:I	Semester:**I/Paper-II**

Subject:**Botany**

Course Code:B040102P	CourseTitle:**Techniquesin Microbiology&PlantPathology**

Courseoutcomes: Afterthecompletionofthecoursethestudents willbeable:

1. Understandtheinstruments,techniques,labetiquettesandgoodlabpracticesforworkinginamicrobiologylaboratory.
2. Developskillsforidentifyingmicrobesandusingthemfor Industrial,AgricultureandEnvironmentpurposes.
3. Practicalskillsinthefieldand laboratoryexperimentsinMicrobiology&Pathology.
4. learntoidentifyAlgae,Lichensandplantpathogensalongwiththe irSymbioticandParasiticassociations.
5. Caninitiatehisown Plant &SeedDiagnosticClinic
6. Canstartownenterpriseonmicrobialproducts

Credits:**2**	**CoreCompulsory**
Max.Marks:**25+75**	Min.PassingMarks:
TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**0-0-2**	

Courseprerequisites:
Qualification: Tostudythiscourse,astudentmusthavequalified10+2withBiology/NSQFlevel3fromSectorSkillCouncils/DiplomaholderfromITI in(Biology/Agriculture/Biotech/Microbiology/biomedicalScience.
Facilities:SmartandInteractiveClass
OtherRequisites:Videocollection,Books,CDs,AccesstoOn-lineresources,DisplayCharts
LabRequisites:Microscopes,Stains,Dissectionbox,Haemocytometer,Specimens,Permanentslides,Autoclave,incubator, Oven,laminarflow cabinet,balances,Fermenter,AnaerobicjarandSpectrophotometer.

Suggestedequivalentonline courses:
https://community.plantae.org/tags/mooc
futurelearn.com/courses/teaching-biology-inspiring-students-with-plants-in-sciencehttps://microbiologysociety.org/publication/education-outreach-resources/basic-practical-microbiology-a-manual.htmlhttps://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175c.pdf
http://allaboutalgae.com/benefits/https://repository.cimmyt.org/xmlui/bitstream/handle/10883/3219/64331.pdfhttps://www.mooc-list.com/tags/microbiology
http://www.agrifs.ir/sites/default/files/A%20text%20book%20of%20practical%20botany%201%20%7BAshok%20Bendre%7D%20%5B8171339239%5D%20%281984%29.pdf
https://www.coursera.org/courses?query=plants
http://egyankosh.ac.in/handle/123456789/53530https://www.classcentral.com/tag/microbiologyhttps://www.edx.org/learn/microbiologyhttps://www.mooc-list.com/tags/microbiologyhttps://www.udemy.com/topic/microbiology/

Programme/Class:B.Sc.-I/ ***CertificateCourseIn MicrobialTechnology&ClassicalBotany***	Year:I	Semester:II **Paper-I**
Subject: **Botany**		
Course Code:B040201T	CourseTitle:**ArchegoniatesandPlantArchitecture**	

Courseoutcomes:
Afterthecompletionofthecoursethestudents willbeableto:
1. Developcriticalunderstandingonmorphology,anatomyandreproductionofBryophytes,PteridophytesandGymnosperms
2. Understandingofplantevolutionandtheir transitiontolandhabitat.
3. Understand morphology,anatomy,reproductionanddevelopmentalchangesthereinthroughtypologicalstudyandcreateaknowledgebaseinunderstandingthebasisofplantdiversity,economicvalues&taxonomyofplants
4. Understandthedetailsofexternaland internalstructuresofflowering plants.

Credits:**4**	**CoreCompulsory**
Max.Marks: **25+75**	Min.PassingMarks:
TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**4-0-0**	

Programme/Class: *CertificateCourse inMicrobial Technology&ClassicalBotany*	Year:I	Semester:II **Paper-II(Practical)**
Subject: **Botany**		
Course Code:B040202P	CourseTitle:**LandPlantsArchitecture**	

Courseoutcomes:

1. The students will be made aware of the group of plants that have given rise to land habit and the flowering plants.Throughfieldstudytheywillbeabletoseetheseplantsgrowinnatureandbecomefamiliar withthebiodiversity.
2. Students would learn to create their small digital reports where they can capture the zoomed in and zoomed outpicturesas wellasvideosincasetheyareabletofindsomerarestructureorphenomenonrelatedtotheseplants.
3. Developanunderstandingbyobservationand tablestudyofrepresentativemembersofphylogeneticallyimportantgroupstolearnthe processofevolutionina broadsense.
4. Understandmorphology,anatomy,reproductionanddevelopmentalchangesthereinthroughtypologicalstudyandcreate aknowledgebaseinunderstandingplantdiversity,economicvalues&taxonomyoflowergroupofplants
5. Understandthecomposition,modifications,internalstructure&architectureoffloweringplantsforbecomingaBotanis t.

Credits:2	**CoreCompulsory**
Max.Marks:**25+75**	Min.PassingMarks:

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**0-0-2**

Unit	Topic (Any three from each unit)	No.ofLectures
I	**Bryophytes:** *Marchantia*-morphologyofthallus,W.M.rhizoidsandscales,V.S.thallusthroughGemma cup, W.M. gemmae (all temporary slides), V.S. antheridiophore,archegoniophore,L.S.sporophyte(all permanentslides).*Sphagnum*-morphology, W.M.leaf,rhizoids,operculum,peristome,annulus,spores(temporaryslides);per manent slides showing antheridial and archegonial heads, L.S. capsule andprotonema.	8
II	**Pteridophytes:** *Lycopodium*: Habit, stem T. S. strobilus V. S.,*Selaginella*: Habit, rhizophore T. S,stem T . S, axis with strobilus, V.S. of strobilus, Megasporophyll andmicrosporophyll. *Equisetum*-Habit,rhizomeand stemT.S.and V.S.ofstrobilus. *Azolla*– Habitat&itsstructure	7
III	**Gymnosperms** 1. *Cycas* – seedling, coralloid root and coralloid root T. S., T. S. of leaflet andRachis, micro and megasporophyll, male cone V. S., microsporophyll T. S. entireandV.S.ofovule. *Pinus*-Branchofindefinitegrowth,spurshoot,T.Sofold stemand needle R.L.S and T. L. S. of stem, male and female cone, V.S. of male andfemalecone. 2. *Ephedra &Thuja*:Habit,stemT.S(youngandmature),leafT.S,maleandfemalestrobilus,V.S .of maleand femalecone, ovuleV.S.and seed.	8
IV	**Palaeobotany** 1. Morphologyof*Rhynia*andfossilsgymnosperms&other groups. 2. Visit Birbal Sahni Institute ofPalaeosciencesor virtual conference with their scientists to learnfossilization. 3. Markand knowaboutIndiangeographicalsitesrichinplantfossils.	6

DiplomainPlantIdentification,Utilization&Ethnomedicine

DiplomainPlantIdentification,Utilization&Ethnomedicine		
Programme/Class:***DiplomainPlantIdentification,Utilization&Ethnomedicine***	Year:**II**	Semester:**III** **Paper-I**
Subject:**Botany**		
Course Code:B040301T	CourseTitle:**FloweringPlantsIdentification&AestheticCharacteristics**	

Courseoutcomes:

Afterthecompletionofthecoursethestudents willbeableto:

1. Togainanunderstandingofthehistoryand conceptsunderlying variousapproachestoplanttaxonomyandclassification.
2. Tolearnthemajorpatternsof diversityamongplants,andthecharactersandtypesofdatausedto classifyplants.
3. Tocomparethedifferentapproachesto classification withregard totheanalysisofdata.
4. Tobecomefamiliarwithmajortaxaandtheiridentifyingcharacteristics,andtodevelopindepthknowledgeofthecurrenttax onomyofamajor plantfamily.
5. Todiscoverandusediversetaxonomicresources,reference materials,herbariumcollections,publications.
6. Fortheentrepreneurcareerinplants,onecanestablishanursery,Startalandscapingbusiness,Set up afarmOrRuna plantationconsultancyfirm

Credits:**4**	**CoreCompulsory**
Max.Marks:**25+75**	Min.PassingMarks:

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**4-0-0**

Unit	Topic	No.ofLectures(60hrs)
I	**TaxonomicResources&Nomenclature** Componentsoftaxonomy(identification,nomenclature,classification);Taxonomicreso urces: Herbarium- functions & important herbaria, Botanical gardens, Flora,Artificial Keys. Binomial Nomenclature:PrinciplesandrulesofBotanicalNomenclatureaccordingtoICN(ranksandt axa;principle of priority, type method, author citation, valid publication).	7
II	**Typesofclassification&Evidences** Artificial, naturalandphylogenetic.BenthamandHooker(uptoseries), Takhtajaan,AngiospermPhylogenyGroup(APGIV)classification.Introduction to taxonomic evidences from cytology, phytochemistry &Molecular biologydata(ProteinandNucleicacidhomology).	8
III	**IdentificationofAngiospermicfamilies-I:(FamiliescanbechosenUniversitywiseasper localavailableflora)** Acomparative studyofthefollowingfamilies withemphasisonthe morphologicalpeculiaritiesand economic importance of its members (based on Bentham & Hooker's system)Ranunculaceae,Papaveraceae,Malvaceae, Rutaceae, Fabaceae,Myrtaceae , Cucurbitaceae,Apiaceae, Rubiaceae,A s t e r a c e a e .	8
IV	**IdentificationofAngiospermicfamilies-II:(FamiliescanbechosenUniversitywiseasper localavailableflora)** Acomparative studyofthefollowingfamilies withemphasisonthe morphologicalpeculiaritiesand economic importance of its members (based on Bentham & Hooker's system)-Apocynaceae,Asclepiadaceae,Solanaceae, Acanthaceae,Lamiaceae, Amaranthaceae,Euphorbiaceae,Liliaceae, Musaceae, Poaceae.	7

	Programme/Class::*DiplomainPlant Identification,Utilization&Ethnomedicine*	Year:II	Semester:III **Paper-II(Practical)**
	Subject:**Botany**		
	Course Code:B040302P	CourseTitle:**PlantIdentificationtechnology**	

Courseoutcomes:

Afterthecompletionofthecoursethestudentswillbeable:

1. Tolearnhowplant specimensarecollected,documented,andcuratedforapermanentrecord.
2. To observe, record, and employ plant morphological variation and the accompanying descriptiveterminology.
3. Togainexperiencewiththevarioustoolsandmeansavailabletoidentifyplants.
4. Todevelopobservationalskillsandfieldexperience.
5. Toidentifya taxonomicallydiversearrayofnativeplants.
6. Torecognizecommonandmajorplantfamilies.
7. ToUnderstandaestheticcharactersofflowerингplantsbymaking-landscapes,gardens,bonsai,miniatures
8. Comprehendtheconceptsofplant taxonomyandclassificationofAngiosperms.

Credits:2		**CoreCompulsory**
Max.Marks:25+75		Min.PassingMarks:

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):0-0-2

Unit	Topic* *(PerformAnythreeexperimentsfromeachunitasperfacility)	No. of Lecture(60Hrs)
I	**Herbarium:Plantcollection,PreservationandDocumentation:** StepwisePracticingHerbariumtechniques:a.FIELDEQUIPMENTS,GlobalPositioningSystem (GPS) instrument & Collection of any wild 25 plant specimens b. Learn to handleHerbarium making tools c. Pressing and Drying of collected plant specimens d. Specialtreatmentsforvariousgroupsofplantse. Mountonstandardherbariumsheetsf.LabelthemusingStandardmethodg.Organizethemandgive IndexRegister Number	7
II	**TaxonomicIdentificationusingplantstructure** a. Classify 25 plants on the basis of Taxonomic description (Plant Morphology, Anatomy,Reproductive parts, Habit, adaptation anomalies) according to Bentham and Hooker system of classification in the following families: Malvaceae, Fabaceae (Papilionaceae),Solanaceae,Acanthaceae,Labiatae(Lamiaceae),Rubiaceae, Poaceae.	8
III	**Identificationduringexcursions** a.Conducting Spot identification (Binomial, Family) of common wild plants from familiesincludedinthetheoreticalsyllabus(listtobeprovided)andmakingFIELDNOTEBOOK and fillingSample ofa pageoffield-book,usedinBotanicalSurveyofIndia. b. Describe/compare flowers in semi-technical language giving V.S. of flowers, T.S. ofovaries,FloraldiagramsandFloralFormulae.Identifyandassignthemtotheirrespectivefamilies givingreasons.	8
IV	**COLLECTION, PRESERVATION AND STORAGE OF ALGAE, FUNGIBRYOPHYTES, PTERIDOPHYTES(Twoeach)**	7
V	**BotanicalNomenclature&reportingMethod:** a. Givenomenclatureto collectedplantsasperICNrulesandpreparelabelsasperBSI **b. Author Citation, Effective Publication and Principle of Priority:** To show a specimen paperonBasicstructureofataxonomicResearchpublishedonanewspeciesintaxonomicJournal	7

	Aprojectsupportedalongwithphotographstakenduringfieldstudytobesubmittedgivingcomprehensive Idea aboutdifferenttypesofinflorescence,flowersandfruits/ Atleastthreefieldexcursions athills/Oceans/DesertsincludingoneCompulsoryexcursiontoBotanical Garden,FRI/BSIand Central NationalHerbarium(CNH).CentralResearchInstitutes/HotSpots

Programme /Class: ***Diploma in PlantIdentification,Utilization&Ethnomedicine***	Year:**II**	Semester: **IVPaper-I**
Subject:**Botany**		
Course Code:B040401T	CourseTitle:**EconomicBotany,EthnomedicineandPhytochemistry**	

Courseoutcomes:

Afterthecompletionofthecoursethestudentswillbeableto:

1. Understandabout theusesofplants–will knowoneplant-oneemployment
2. Understandphytochemicalanalysisrelatedtomedicinallyimportantplantsandeconomicproductsproducedbythe plants
3. knowabouttheimportanceofMedicinalplantsanditsusefulparts,economicallyimportantplantsinour dailylifeandalsoaboutthetraditionalmedicinesandherbs,anditsrelevancein moderntimes.

Credits:4	**CoreCompulsory**
Max.Marks:**25+75**	Min.PassingMarks:

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**4-0-0**

Unit	Topic	No. ofLectures (60hrs)
I	**Originanddomesticationofcultivatedplants** Centersofdiversityofplants,originofcropplants.Domesticationandintroductionofcropplants.Concepts of sustainable development; cultivation, production and uses of Cereals, legumes,Spices&beverages.	7
II	**Botanyofoils,Fibers,timberyielding plants&dyes** Study of the plants with Botanical names, Family, part used, and economic uses yielding Edible&essentialoils;Sugar,Starch;Fibers;Paper,Fumigatories&Masticatories,Rubber,Dyes,Timber,biofuelcrops.	7
III	**Commercial production of Flowers, Vegetables, and fruits (To be Chosen area wise)**Commercialgreenhousecultivationofrose,*Gerbera,Gladiolus,Anthurium*/lilium/lily,tomato,bellpepper,cucumber,strawberry&Exoticleafyvegetables usingHydroponics.	7
IV	**IPR&TraditionalKnowledge** IPR and WTO (TRIPS, WIPO), Patent Act 1970 and its amendments, TIFAC, NRDC, Rights,Procedure of obtaining patents, Working of patents, Infringement, Copyrights, Trademarks,GeographicalIndications, TraditionalKnowledge DigitalLibrary,ProtectionofTraditional Knowledge&ProtectionofPlantVarietiesandBiotechinventions.	8
V	**Ethnobotany** Methodologiesofethnobotanicalresearch:Fieldwork,Literature,HerbariaandMuseaandotheraspects of ethnobotany. Importance of ethnobotany in Indian systems of medicine (Siddha,AyurvedaandUnani),Role ofAYUSH, NMPB,CIMAPand CARI. Tribalknowledgetowardsdiseasediagnosis,treatment,medicinalplants,plantconservationandcultivation.	8

Programme: *DiplomainPlantIdentification,Utilization&Ethnomedicine*	Year: II	Semester: **IVPaper-II**
Subject: **Botany**		
CourseCode:B040402P	CourseTitle:**CommercialBotany&PhytochemicalAnalysis**	

Courseoutcomes: Afterthecompletion ofthecoursethe studentswill be able to:

1. Knowaboutthecommercial products producedfromplants.
2. Gaintheknowledgeaboutcultivationpracticesofsomeeconomiccrops.
3. Understandabouttheethnobotanicaldetailsofplants.
4. Learnaboutthe chemistryofplants&herbalpreparations
5. Canbecomeaprotectedcultivator,aromaticoilproducer,Pharmacologistorqualityanalystindrugcompany.

Credits:**2**	**CoreCompulsory**
Max.Marks: **25+75**	Min.PassingMarks:

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**0-0-2**

Unit	Topic (Performminimumany threeexperiments fromeachunit)	No.of Lectures (60hrs)
I	**EconomicBotany&Microtechnique:** Cereals:Wheat(habitsketch,L.S./T.S.ofgrain,starchgrains,micro-chemicaltests);rice(habitsketch,studyofpaddyand grain, starch grains,micro-chemicaltests) Legume:Peaorgroundnut(habit,fruit,seedstructure,micro-chemical tests) Source of sugars and starches: Sugarcane (habit sketch; cane juice- micro-chemicaltests); potato (habitsketch, tuber morphology, T.S. of tuber to show localization ofstarchgrains,W.M.ofstarch) grains, micro-chemicaltests. Tea-tealeaves,testsfortannin Mustard-plant specimen,seeds,testsforfatincrushedseedsTimbers:section of youngstem. Jute-specimen,transversesectionofstem,testsforlignonT.S.ofstemandstudyoffiberfollowingmacerationtechnique. StudyofspecimensofeconomicimportancementionedinUnit I-&II	8
II	**CommercialCultivation** Field visit to Green houses for understanding Floriculture & vegetables productionDevelopmentofhydroponicsnutrientsolutions&runningmodelsforcultivationofvegetables Developmentofhydroponicsnutrientsolutions&runningmodelsforcultivationoffodder	8
III	**CultivatingMedicinalandaromaticplants&Essentialoil extraction** a.Lemongrass/Neem/Zinger/Rose/Mint	7
IV	**Documentation from** Traditional Knowledge Digital Library,MarktheGeographic Indications onMap, Understand–NakshtraVatika, Navgrahvatikaanddevelopinyourcollege Toextract thenamesoftheplantsandBotanical usesdepictedinourepics.Visit NISCAIR,New Delhi	7

BACHELOROFSCIENCE(BOTANY)

Programme/Class:*BachelorofScience*	Year:III	Semester:V Paper-I
Subject:BOTANY		
CourseCode:B040501T	CourseTitle:**PlantPhysiology,Metabolism&Biochemistry**	

Courseoutcomes:

Afterthecompletionofthecoursethestudents willbe ableto:

1. Understandthe roleof Physiologicalandmetabolicprocesses forplant growthanddevelopment.
2. Learnthesymptomsof MineralDeficiencyincrops andtheirmanagement.
3. AssimilateKnowledgeaboutBiochemicalconstitutionofplantdiversity.
4. Knowtheroleofplantsindevelopmentofnaturalproducts,nutraceuticals,dietarysupplements,antioxidants

Credits:4	**CoreCompulsory**
Max.Marks: **25+75**	Min.PassingMarks:

TotalNo.ofLectures-Tutorials-Practical(in hoursperweek)4-0-0

Unit	Topic	No. ofLectures(60hrs)
I	**Plant water relation, Mineral Nutrition, Transpiration and translocation in phloem**Importanceofwater,waterpotentialanditscomponents;Transpirationanditssignificance;Factorsaffectingtranspiration;Rootpressure andguttation. Criteriaofessentialityofelements;Roleofessentialelements;Symptomsofmineraldeficiencyin major crops, Transportofionsacrosscellmembrane,activeandpassivetransport,Compositionofphloemsap,girdlingexperiment;Pressure flowmodel.	7
II	**CarbonOxidation** Krebs cycle, Glycolysis, fate of pyruvate- aerobic and anacrobic respiration and fermentation,regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation ofpyruvate,regulationofKrebscycle,mitochondrialelectrontransport,oxidativephosphorylation, ATP-Synthetase,Chemiosmoticmechanism,P/Oratio,cyanide-resistantrespiration,factorsaffectingrespiration.	7
III	**NitrogenMetabolism** Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes),Physiologyandbiochemistryofnitrogenfixation,Ammoniaassimilation(GS-GOGAT),reductiveaminationand transamination, amino acidsynthesis.	8
IV	**LipidMetabolism&Photosynthesis** LipidMetabolism:Synthesisandbreakdownoftriglycerides,-oxidation,glyoxylatecycle,gluconeogenesisanditsroleinmobilizationoflipidsduringseedgermination,-oxidation.; Photosynthesis:Pigments,ActionspectraandEnhancementeffect,Electrontransportsystemand Photophosphorylation,C3&C4photosynthesis,CAM-Reactionand Significance	7
V	**PlantDevelopment,Movements,Dormancy&Responses** Developmental roles of Phytohormones (auxins, gibberellins, cytokinins, ABA, ethylene.)autonomic & paratonic movements, Photoperiodism(SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red-lightresponsesonphotomorphogenesis,Seed physiology &Dormancy,Vernalization& Senescence	8

Programme/Class: *BachelorofScience*	Year:**III**	Semester:**V** **Paper-III**
Subject:**Botany**		
CourseCode:B040503P	CourseTitle:***Experimentsinphysiology, Biochemistry& molecularbiology***	

Courseoutcomes:

Afterthecompletionofthecoursethestudents willbe ableto:

1. Knowandauthenticthephysiologicalprocessesundergoinginplantsalongwiththeirmet abolism
2. IdentifyMineraldeficienciesbased onvisualsymptoms
3. Understandanddevelopskillforconductingmolecularexperimentsforgeneticengineeri ng

Credits:2	**CoreCompulsory**
Max.Marks: **25+75**	Min.PassingMarks:

TotalNo.ofLectures-Tutorials-Practical(in hoursperweek)0-**0-2**

Unit	Topic* **(Performanythreefrom eachunitbasedonfacility)*	No. ofLectures(60hrs)
I	**Plantwaterrelation,MineralNutritionandtranslocationinphloem** 1.Determination ofosmoticpotentialofplantcellsapbyplasmolyticmethodusingleavesof *Rhoeo/Tradescantia.* 2.Osmosis –bypotatoosmoscopeexperiment 3.EffectoftemperatureonabsorptionofwaterbystoragetissueanddeterminationofQ10. 4.Experimenttodemonstratethetranspirationphenomenonwiththebelljarmethod 5.Experimentfordemonstrationof TranspirationbyFour-LeafExperiment: 6.Structureofstomata(dicot& monocot) 7.Determinationofrateoftranspirationusingcobalt chloridemethod. 8.Experimenttomeasuretherateoftranspirationbyusing Farmer'sPotometer 9.Experimenttomeasuretherateoftranspirationbyusing Ganong'spotometer 10. EffectofTemperatureonmembranepermeabilitybycolorimetricmethod. 11. Studyofmineraldeficiencysymptomsusingplant material/photographs.	8
II	**NitrogenMetabolism,PhotoSynthesis&Respiration** 1. Abasicideaofchromatography:Principle,paperchromatographyandcolumnchromatograph y;demonstrationofcolumnchromatography. 2. Separationofplastidialpigmentsbysolventandpaperchromatography. 3. Estimationoftotalchlorophyllcontentfromdifferentchronologicallyagedleaves(young,matu reandsenescence) byArnon method. 4. Effect of HCO_3concentration on oxygen evolution during photosynthesis in an aquaticplantandtofindouttheoptimumandtoxicconcentration(eitherbyvolumemeasurementor bubblecounting). 5. Measurementofoxygenuptakebyrespiringtissue(perg/hr.)6.De terminationoftheRQ ofgerminatingseeds. 7.Effectoflightintensityon oxygenevolutioninphotosynthesisusingWilmott'bubble	8
III	**PlantDevelopment,Movements,Dormancy&Responses** 1. Geotropismandphototropism—Klinostat 2. Hydrotropism a. Measurementofgrowth—ArcandLiver Auxenometer 3. Tostudythephenomenonof seedgermination (effectoflight). 4. Tostudytheinductionofamylaseactivityingerminatinggrains.	8

Programme/Class:**BachelorofScience**	Year:**III**	**Semester: VPaper-IV**
Subject:**BOTANY**		
CourseCode:-B040504R	CourseTitle:**ProjectinBotanyforPre-graduation**	

Courseoutcomes:

- Projectworkwillsupplementfieldexperimentallearninganddeviationsfromclassroomandlaboratorytransactions.
- projectworkwillenhancethecapabilitytoapplygainedknowledgeandunderstandingforselecting,solving anddecision-makingprocesses.
- It willpromotecreativityand thespiritofenquiryinlearners.
- They will learn to consult Scientists, libraries, laboratories and herbariums and learn Importance of discussions,Botanical & field trips, print and electronic media, internet etc. along with data documentation, compilation,analysis &representationinformofdissertation writing.
- Itwillenhancetheirabilities,enthusiasm,andinterest.

Credits:**03**	Core:**Compulsory**
Max.Marks: **25+75**	Min.PassingMarks: .....

TotalNo.ofLectures-Tutorials-Practical(inhoursper week):**0-0-3.**

SuggestiveListOfPROJECTS

1. RuralAreas:Floraofacity/ village,BiodiversityofVillage,Soil&seedtestingserviceprovisiontofarmers,
2. Industrialwastemanagement
3. waterpollutionstatusofrural water&promotionofWASHinvillages
4. PlantDiseaseidentificationinfarms, nurseriesandorchards.
5. Digitalportalforplants:Campus,cityorparticulararea
6. Rareandendangeredplants&theirconservation&domestication
7. Airpollutiontoleranceindex(APTI):Screeningofsensitive/tolerantplantspeciesatvariouslocationsinparticular area
8. ScienceCommunicationbyCreatingsciencedocumentariesofinnovators,InternetScience(Socialmedia,Websites, Blogs, Youtube,Podcastetc.)
9. ScienceOutreachTalksandPublicSensitizationforplant biodiversityconservationsensitizationofpublic.
10. Phytochemistryofmedicinalplants&theirantimicrobial,nutraceuticalandantioxidantproperties
11. Studyofpollengrainsindifferent flowers12.Studyofstomata indifferentplants
13. Studyofvarioustypesofsecretoryand specialtissuesinplants.

Refer:libraries,journals,Memoirs,encyclopaedias,herbaria,Museums,etc.

Thiscoursecanbeoptedasanelectivebythestudentsof followingsubjects: **Opentoall**

SuggestedContinuousEvaluationMethods:

ContinuousInternalEvaluationshallbebasedonallottedAssignmentandClassTests.Themarksshallbeasfollows:

InternalAssessment	Marks
ClassInteraction	5
Seminar	10
Thesis/dissertation	10
	25

Courseprerequisites:

Programme/Class:***Bachelorof Science***	Year:**III**	Semester:**VI** **Paper-I**
Subject:**Botany**		
CourseCode:B040601T	CourseTitle:**Cytogenetics,PlantBreeding&Nanotechnology**	

Courseoutcomes: Afterthecompletionofthecoursethestudents willbeable:

1. Acquireknowledgeoncellultrastructure.
2. Understandthestructureandchemicalcompositionofchromatinandconceptofcelldivision.
3. InterprettheMendel'sprinciples,acquireknowledgeoncytoplasmicinheritanceandsex-linkedinheritance.
4. Understandtheconceptof'onegeneoneenzymehypothesis'alongwiththe molecularmechanismofmutation.

Credits:**4**	**CoreCompulsory**
Max.Marks: **25+75**	Min.PassingMarks:

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**4-0-0**

Unit	Topic	No. ofLectures (60hrs)
I	**Cellbiology** Structure and function of cell wall, plasma membrane, ribosomes, Endoplasmic reticulum,golgi apparatus, mitochondria, chloroplast, lysosomes, peroxisomes and cell inclusions -Organizationof nucleus:nuclearenvelope,nucleoplasmandnucleolus. Chromosomalnomenclature-chromatids,centromere,telomere,satellite,secondaryconstriction.Organizationofchromosomes -Nucleicacidandhistones-typesandclassification.Lampbrushchromosomesandpolytenechromosomes-Karyotypeandidiogram.Cellcycle:–mitosis:openandclosedmitosis–amitosis-meiosis.VariationinChromosomenumber(Numericalaberrations)-aneuploidyandEuploidy-haploidy, polyploidy- significance (Structural aberrations) - deletion, duplication,inversionandtranslocation.	8
II	**Genetics** Chromosometheoryofinheritance,crossingoverandlinkage;Incompletedominanceandcodominance; Interaction of Genes; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy,Polygenic inheritance; Extra-nuclear Inheritance, Linkage, crossing over, Concept of sexdeterminationandSexchromosomes;PatternsofSexdeterminationinplants	7
III	**Plantbreeding** Plant introduction.Agenciesof plant introductioninIndia, Procedure of introduction-Acclimatization – Achievements, Selection - mass selection, pure line selection and clonalselection.Geneticbasisofselectionmethods,Hybridization:Procedureofhybridization,intergeneric, inter specific, inter varietal hybridization with examples. Composite and syntheticvarieties, Male sterility, Heterosis and its exploitation in plant breeding, Mutation, MolecularBreeding(useofDNAmarkersinplantbreeding),achievementsinIndia,Breedingforpest, pathogenicdiseasesandstressresistance.	8
IV	**Biostatistics:** Definition,statisticalmethods,basicprinciples,variables-measurements,functions,limitations and uses of statistics. Biometry: Data, Sample, Population, random sampling,Frequency distribution-definitiononly,Centraltendency–ArithmeticMean,ModeandMedian;Measurementofdispersion–Coefficientofvariation,StandardDeviation,Standard errorofMean;Testofsignificance:chi-squaretestforgoodnessoffit.Computerapplicationinbiostatistics-MS ExcelandSPSS	7

Programme/Class:*BachelorofScience*	Year:**III**	Semester:VI **Paper-II**
Subject:**Botany**		
Course Code:B040602T	CourseTitle:**Ecology&Environment**	

Courseoutcomes:

1. acquaintthestudentswithcomplexinterrelationshipbetweenorganismsandenvironment;
2. makethemunderstandmethodsforstudyingvegetation,communitypatternsandprocesses,ecosystemfunctions, and principlesofphytogeography.
3. Thisknowledgeiscriticalinevolvingstrategiesforsustainablenaturalresourcemanagementand biodiversityconservation.

Credits:**4**	**CoreCompulsory/Elective**
Max.Marks: **25+75**	Min.PassingMarks:

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**4-0-0**

Unit	Topic	No. of Lectures(60 hrs)
I	**Natural resources & Sustainable utilization**: Land Utilization, Soil degradation andmanagement strategies; Restoration of degraded lands. Water, Wetlands; Threats andmanagementstrategies,Ramsarsites,Forests:Majorandminorforestproducts;Depletion,BiologicalInvasion,Energy:Renewableandnon-renewablesourcesofenergy, Contemporary practices in resource management: EIA, GIS, ParticipatoryResourceAppraisal,EcologicalFootprintwith emphasisoncarbon footprint,Resource Accounting.	7
II	**Ecology&Ecosystem** DefinitionofEcology,EcologicalFactors,Positiveandnegativeinteractions.Ecosystem –Conceptofanecosystem-structureandfunctionofanecosystem.Abioticandbiotic components and their interrelationship- Biogeochemical and hydrological cycles, and Energyflowinanecosystem EcologicalSuccession-Definition&types.Processesandtypes(autogenic,allogenic,autotrophic,heterotrophic,primary&secondary),Hydrosereand Xerosere. Foodchainsandfoodwebs, Concept of Ecological perturbations and balance,Ecologicalpyramids,Primary and Secondary ProductionandProductivity;Types of ecosystems: Natural and Man-made- Forest Grassland, Aquatic and Agro- Ecosystems.EcologicalAdaptations–Hydrophytes,Xerophytes,Halophytes,EpiphytesandParasites.	8
III	**SoilFormation,Properties&Conservation** Soil: Origin, Formation, composition, Soil types, Soil Profile, Soil Microorganisms, soilprocesses, Soil Erosion, Biogeochemical cycles, Soil Conservation: Biological–Contourfarming,Mulching,Stripcropping,TerracingandCroprotation.Mechanical–BasinListing,Constructionofdams,WatershedManagement,Soilreclamation	7
IV	**Biodiversityanditsconservation:** Definition-genetic,species,andecosystemdiversity.Valueofbiodiversity:In d i a n socio-cultural,ethical andaestheticvalues;hotspotsofBiodiversitythreatstobiodiversity,Bioticcommunitiesandpopulations,theircharacteristicsanddynamics.Endemicandendangered species of plants in India. Ecological niche, ecade, ecotypes, ecological indicators.Conservation ofBiodiversity: *Ex-situ*and*in-situ*conservation,Reddatabook,botanicalgardens,Nationalpark,Sanctuaries,hot&hottestspots and Biosphere reserves.RoleofSeed Bankand GeneBank Valuingplantresources,ecotourism,RoleofNBPGR,FAO,BSI, Indian value system	7

InternalAssessment	Marks
ClassInteraction	5
Quiz	5
Seminar	7
Assignment(Charts/Flora/RuralService/TechnologyDissemination)	8
	25

Courseprerequisites:
Qualification: Tostudythiscourse,astudentmusthavequalified10+2withBiology/NSQFlevel3fromSectorSkillCouncils/ DiplomaholderfromITIin(Biology/Agriculture/Biotech/Forestry/Microbiology/Gardening/biomedicalScience.
Facilities:SmartandInteractiveClass
OtherRequisites:Videocollection,Books,CDs,AccesstoOn-lineresources,DisplayCharts

Suggestedequivalentonline courses:
https://community.plantae.org/tags/mooc
uturelearn.com/courses/teaching-biology-inspiring-students-with-plants-in-sciencehttps://www.coursera.org/courses?query=plantshttp://egyankosh.ac.in/handle/123456789/53530

Programme/Class:*BachelorofScience*	Year:**III**	Semester:VI **Paper-III**
Subject:**Botany**		
CourseCode:B040603P	CourseTitle: **LabonCytogenetics,Conservation& Environmentmanagement**	

Courseoutcomes: Afterthecompletionofthecoursethestudents willbeable:

1. Toperformallexperimentsrelatedtothesemester-i.e.Plant tissueculturedplants,conductingbreedingonfield,conservinganddepollutingthe environment.
2. Canbeemployedinenvironmentimpactassessmentcompanies &start hisownventure

Credits:2	**CoreCompulsory**
Max.Marks: **25+75**	Min.PassingMarks:

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):0-0-2

Unit	Topic (Any three from each unit)	No. ofLectures(60hrs)
I	**Cellbiology** 1. Studyofplantcellstructurewiththehelpofepidermalpeal mount ofOnion/*Rhoeo/Crinum* 2. Measurementofcellsizebythetechniqueofmicrometry. 3. Countingcellsperunit volumewiththehelpofhaemocytometer(Yeast/pollengrains) 4. Determinationofmitoticindexandfrequencyofdifferentmitoticstages inpre-fixed roottips of *Alliumcepa.*	7

Coursepre-requisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech/Math/Statistics/Chemistry/Computer Science)
Facilities:SmartandInteractiveClass
OtherRequisites:Videocollection,Books,CDs,AccesstoOn-lineresources,DisplayChartsLabrequisites: Biotechinstruments,environmentallab instruments.

Suggestedequivalentonlinecourses:
https://www.cytology-iac.org/educational-resources/virtual-slide-libraryhttps://www.asct.com/ASCTWeb/Content/Cytopreparation_Online_Course.aspxhttps://www.mooc-list.com/tags/genetics
https://www.coursera.org/learn/genetics-evolution
https://www.my-mooc.com/en/mooc/introduction-to-genetics-and-evolution/

Further Suggestions: Access to Statistics, Chemistry, Math and Biotechnology resources will berequired

Programme/Class:**BachelorofScience**	Year:**III**	Semester: **VI /Project-II/ Paper-IV**
Subject:**BOTANY**		
CourseCode:-B040604R	CourseTitle:**ProjectinBotanyforGraduation**	

Courseoutcomes:
Aftercompletingthiscourseastudentwill have:

- Projectworkwillsupplementfieldexperimentallearninganddeviations fromclassroomandlaboratorytransactions.
- projectworkwillenhancethecapabilitytoapplygainedknowledgeandunderstandingfor selecting,solvinganddecision-makingprocesses
- It willpromotecreativityand thespiritofenquiryinlearners.
- Theywilllearntoconsult Scientists,libraries,laboratoriesandherbariumsandlearnimportanceofdiscussions,Botanical & field trips, print and electronic media, internet etc. along with data documentation, compilation,analysis &representationinformofdissertationwriting
- Itwillenhancetheirabilities,enthusiasm,andinterest.

Credits:**03**	Core:**Compulsory**
Max.Marks:**25+75**	Min.PassingMarks:.....

TotalNo.ofLectures-Tutorials-Practical(inhoursper week):**0-0-3.**

SUGGESTIVELISTOFPROJECTS

Preparebedsforgrowingnurseryforherbs,shrubsandtrees.Develop Green house facility in college and grow plantsDevelophydroponicsfacilityincollegeand growplants.
Developbotanicalgardeninthecollegewithlabelling
Verticalgardens, roofgardens
Culture&artofmakingbonsai.
PhytochemicalAnalysisofMedicinalplants

PROGRAM SPECIFIC OUTCOMES (PSOS)	
CERTIFICATE IN BIOORGANIC AND MEDICINAL CHEMISTRY	
First Year	Certificate in Bioorganic and Medicinal Chemistry will give the student a basic knowledge of all the fundamental principles of chemistry like molecular polarity , bonding theories of molecules, Periodic properties of more than 111 elements, mechanism of organic Reactions, Stereochemistry, basic mathematical concepts and computer knowledge, chemistry of carbohydrates, proteins and nucleic acids: medicinal chemistry, synthetic polymers, synthetic dyes, Student will be able to do to qualitative quantitative and biochemical 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 and enable our students to join the knowledge and available opportunities related to chemistry in the government and private sector services particularly in the field of food safety, health inspector, pharmacist etc. Have a broad foundation in chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective.
Second Year	**DIPLOMA IN CHEMICAL DYNAMICS AND ANALYTICAL TECHNIQUES**
	Diploma in Chemical Dynamics and Analytical Techniques will provide the theoretical as well as practical knowledge of handling chemicals, apparatus, equipment and instruments. The knowledge about feasibility and velocity of chemical reactions through chemical kinetics, chemical equilibrium ,phase equilibrium, kinetic theories of Gases ,solid and liquid states, coordination chemistry, metal carbonyls and bioinorganic will enable the students to work as chemists in pharmaceutical industries. The knowledge about atomic structure, quantum mechanics, various spectroscopic tools and separation technique will make the students skilled to work in industries: Achieved the skills required to succeed in the chemical industry like cement industries, agro product, paint industries, rubber industries, petrochemical industries, food processing industries, Fertilizer industries, pollution monitoring and control agencies etc. Got exposures of a breadth of experimental techniques using modern instrumentation Learn the laboratory skills and safely measurements to transfer and interpret knowledge entirely in the working environment. monitoring of environment issues: monitoring of environmental pollution problems of atmospheric sciences, water chemistry and soil chemistry and design processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
Third Year	**DEGREE IN BACHELOR OF SCIENCE**
	Degree in Bachelor of Science programme aims to introduce very important aspects of modern day course curriculum, namely, chemistry of hydrocarbons, alcohols, carbonyl compounds, carboxylic acids, phenols, amines, heterocyclic compounds, natural products main group elements, qualitative analysis, separation techniques and analytical techniques. It will enable the students to understand the importance of the elements in the periodic table including their physical and chemical nature and role in the daily life and also to understand the concept of chemistry to interrelate and interact to the other subject like mathematics, physics, biological science etc. · Upon completion of a degree, chemistry students are able to employ critical thinking and scientific inquiry in the performance, design, interpretation and documentation of laboratory experiments, at a level suitable to succeed at an entry-level position in chemical industry or a chemistry graduate program · Various research institutions and industry people in the pharmaceuticals, polymers, and food industry sectors will surely value this course.

Semester-1,
Paper-1 (Theory)
Course Title: Fundamentals of Chemistry

Programme/Class: Certificate in Bioorganic and Medicinal Chemistry	Year: First	Semester: First
		Paper-1 Theory Subject: Chemistry
Course Code:B020101T	Course Title: Fundamentals of Chemistry	

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.
- The chapter Recapitulation of basics of organic chemistry gives the most primary and utmost important knowledge and concepts of organic Chemistry.
- 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 , steriochemistry 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 chapters Steriochemistry gives the clear picture of two-dimensional and three-dimensional structure of the molecules, and their role in reaction mechanism.

Credits: 4	Compulsory
Max. Marks: 25+75	Min. Passing Marks:.....
Total No. of Lectures = 60	

Unit	Topics	No. of Lectures
I	*Introduction to Indian ancient Chemistry and contribution of Indian Chemists, in context to the holistic development of modern science and technology, should be included under Continues Evaluation (CIE)*	10

Semester-I, Paper-2 (Practical)

Course Title: Quantitative Analysis

Programme: Certificate in Bioorganic and Medicinal Chemistry	Year: First	Semester: I
Practical paper-2		Subject: Chemistry
Course Code: B020102P	**Course Title: Quantitative Analysis**	

Course outcomes:

Upon completion of this course the students will have the knowledge and skills to: understand the laboratory methods and tests related to estimation of metals ions and estimation of acids and alkali contents in commercial products. · Potability tests of water samples.

- Estimation of metal ions in samples
- Estimation of alkali and acid contents in samples
- Estimation of inorganic salts and hydrated water in samples

Credits: 2	Elective
Max. Marks: 25+75 = 100	Min. Passing Marks:
	Practical 60 h

Unit	Topics	No of Lectures
I	**Water Quality analysis** 1. Estimation of hardness of water by EDTA. 2. Determination of chemical oxygen demand (COD). 3. Determination of Biological oxygen demand (BOD).	16
II	**Estimation of Metals ions** 1. Estimation of ferrous and ferric by dichromate method. 2. Estimation of copper using thiosulphate.	14
II	**Estimation of acids and alkali contents** 1. Determination of acetic acid in commercial vinegar using NaOH. 2. Determination of alkali content – antacid tablet using HCl. 3. Estimation of oxalic acid by titrating it with $KMnO_4$.	14
IV	**Estimation of inorganic salts and hydrated water** 1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture. 2. Estimation of calcium content in chalk as calcium oxalate by permanganometry. 3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.	16

Semester-II Paper-1

Course Title: Bioorganic and Materials Chemistry

Programme: **Certificate in Bioorganic and Medicinal Chemistry**	Year: 1	Semester: II
Paper-1	Elective Subject: Chemistry	
Course Code: B020201T	**Course Title: Bioorganic and Medicinal Chemistry**	

Course outcomes: 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, amino acids, proteins, nucleic acids and medicinal chemistry. Upon completion of this course students may get job opportunities in food, beverage and pharmaceutical industries.

Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks:.....

Total No. of Lectures = 60

Unit	Topics	No. of Lectures
I	**Chemistry of Carbohydrates** : Classification of carbohydrates, reducing and non-reducing sugars, General Properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Mechanism of mutarotation Determination of configuration of Glucose (Fischer's proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Inter conversions of sugars (ascending and descending of sugar series, conversion of aldoses to ketoses). Lobry de Bruyn-van Ekenstein rearrangement; stepping–up (Kiliani Fischer method) and stepping–down (Ruff's &Wohl's methods) of aldoses; end-group interchange of aldoses Linkage between monosachharides, structure of disacharrides (sucrose, maltose, lactose.)	10
II	**Chemistry of Proteins:** Classification *of amino acids,* zwitter ion structure and Isoelectric point. Overview of primary, secondary, tertiary and quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C-terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection & C-activating groups and Merrifield solid phase synthesis. Protein denaturation/ renaturation Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions).	10
III	**Chemistry of Nucleic Acids:** Constituents of Nucleic acids: Adenine, guanine, thymine and Cytosine (Structure only), Nucleosides and nucleotides **(nomenclature)**, Synthesis of nucleic	05

Semester-II , Paper-2 (Practical)
Course Title: Biochemical Analysis

Programme: **Certificate in Bioorganic and Medicinal Chemistry**	Year: 1	Semester: II
Subject: Chemistry		
Course Code: B020202P	Course Title: Biochemical Analysis	

Course outcomes:
This course will provide basic qualitative and quantitative experimental knowledge of biomolecules such as carbohydrates, proteins, amino acids, nucleic acids drug molecules. Upon successful completion of this course students may get job opportunities in food, beverage and pharmaceutical industries.

Credits: 2	Elective
Max. Marks: 25+75 = 100	Min. Passing Marks:

Practical 60-h

Unit	Topics	No of Lectures
I	**Qualitative and quantitative analysis of Carbohydrates: .** 1. Separation of a mixture of two sugars by ascending paper chromatography 2. Application of TLC and PC for the identification of natural coloring materials such as Lycopene from Tomato and Chlorophyll from Spinach 3. Differentiate between a reducing/ non reducing sugar 4. Synthesis of Osazones.	15
II	**Qualitative and quantitative analysis of Proteins, amino acids and Fats** 1. Isolation of protein. **2.** Determination of protein by the Biuret reaction. 3. TLC separation of a mixture containing 2/3 amino acids 4. Paper chromatographic separation of a mixture containing 2/3 amino acids 5. Action of salivary amylase on starch 6. To determine the concentration of glycine solution by formylation method. 7. To determine the saponification value of an oil/fat. 8. To determine the iodine value of an oil/fat	20
III	**Determination and identification of Nucleic Acids** 1. Determination of nucleic acids 2. Extraction of DNA from onion/cauliflower	12
IV	**Synthesis of Simple drug molecules** 1. To synthesize aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC. 2. Synthesis of barbituric acid 3. Synthesis of propranolol	13

Semester III, Paper-1 (Theory)
Course Title: Chemical Dynamics & Coordination Chemistry

Programme: Diploma in Chemical Dynamics and Analytical Techniques	Year: Two	Semester: III
		Paper-1 Theory Subject: **Chemistry**
Course Code:B020301T	**Course Title: Chemical Dynamics & Coordination Chemistry**	

Course outcomes: Upon successful completion of this course students should be able to describe the characteristic of the three states of matter and describe the different physical properties of each state of matter. kinetic theory of gases, laws of crystallography , liquid state and liquid crystals, conductometric, potentiometric, optical methods, polarimetry and spectrophotometer technique to study Chemical kinetics and chemical equilibrium. After the completion of the course, Students will be able to understand .metal- ligand bonding in transition metal complexes, thermodynamic and kinetic aspects of metal complexes.

Credits: 4	**Elective**
Max. Marks: 25+75	Min. Passing Marks:.....

Total No. of Lectures = 60

Unit	Topics	No. of Lectures
I	**Chemical Kinetics:** Rate of a reaction, molecularity and order of reaction, concentration dependence of rates, mathematical characteristic of simple chemical reactions – zero order, first order, second order, pseudo order, half-life and mean life. Determination of the order of reaction – differential method, method of integration, half-life method and isolation method. **Theories of chemical kinetics:** Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects (no derivation).	10
II	**Chemical Equilibrium :** Equilibrium constant and free energy, thermodynamic derivation of law of mass action. Le-Chatelier's principle. reaction isotherm and reaction isochore – Clapeyron Clausius equation and its applications.	5
III	**Phase Equilibrium** : Statement and meaning of the terms-phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system– water, CO_2 and systems. Phase equilibria of two component systems – Solid - liquid equilibria , simple eutectic – Bi-Cd, Pb Ag systems.	05

Semester III, Paper-2 (Practical):

Course Title: Physical Analysis

Programme: Diploma in Chemical Dynamics and Analytical Techniques	Year: Two	Semester: III
Practical paper-2		Subject: Chemistry
Course Code. B020302P	**Course Title: Physical Analysis**	
Course Outcomes: Upon successful completion of this course students should be able to calibrate apparatus and prepare solutions of various concentrations, estimation of components through volumetric analysis; to perform dilatometric experiments: one and two component phase equilibrium experiments.		
Credits: 4		Elective
Max. Marks: 25 +75		Min. Passing Marks:
Practical 60 h		

Unit	Topics	No of Lectures
I	**Strengths of Solution** Calibration of fractional weights, pipettes and burettes. Preparation of standards solutions. Dilution –0.1 M to 0.001 M solutions. Mole Concept and Concentration Units :Mole Concept, molecular weight, formula weight, and equivalent weight. Concentration units: Molarity, Formality, Normality, Molality, Mole fraction, Percent by weight, Percent by volume, Parts per thousand, Parts per million, Parts per billion, pH, pOH, milli equivalents, Milli moles	20
II	**Surface Tension and Viscosity** 1. Determination of surface tension of pure liquid or solution 2. Determination of viscosity of liquid pure liquid or solution	06
III	**Boiling point and Transition Temperature** 1. Boiling point of common organic liquid compounds **ANY FIVE**]*n*butylalcohol, cyclohexanol, ethyl methyl ketone, cyclohexanone, acetylacetone, isobutyl methyl ketone, isobutyl alcohol, acetonitrile, benzaldehyde and acetophenone. [Boiling points of the chosen organic compounds should preferably be within 180^{0}C]. 2. Transition Temperature, Determination of the transition temperature of the given substance by thermometric /dialometric method (e.g. $MnCl_2.4H_2O$/$SrBr_2.2H_2O$)	14
IV	**Phase Equilibrium**	20

Semester IV Paper-1 (Theory)

Course Title: Quantum Mechanics and Analytical Techniques

Programme: Diploma in Chemical Dynamics and Analytical Techniques	Year: **Two**	Semester: **IV**
		Paper-1 Elective Subject: **Chemistry**
Course Code: BO20401T	**Course Title:** Quantum Mechanics and Analytical Techniques	

Course Outcomes:: Upon successful completion of this course students should be able to describe atomic structure, elementary quantum mechanics ,wave function and its significance ;Schrodinger wave equation and its applications; Molecular orbital theory, basic ideas – Criteria for forming molecular orbital from atomic orbitals , Molecular Spectroscopy, Rotational Spectrum ,vibrational Electronic Spectrum: photo chemistry and kinetics of photo chemical reaction

Analytical chemistry plays an enormous role in our society, such as in drug manufacturing, process control in industry, environmental monitoring, medical diagnostics, food production, and forensic surveys. It is also of great importance in different research areas. Analytical chemistry is a science that is directed towards creating new knowledge so that chemical analysis can be improved to respond to increasing or new demands.

· 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 IR and NMR spectroscopic techniques

· To develop basic skills required for purification, solvent extraction, TLC and column chromatography

Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks:.....
Total No. of Lectures- = 60	

Unit	Topics	No. of Lectures
I	**Atomic Structure:** Idea of de-Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrödinger wave equation, significance of Ψ and Ψ^2, quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p, d, orbitals. Aufbau and Pauli exclusion principles, Hund's multiplicity rule.	5
II	**Elementary Quantum Mechanics** : Black-body radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (no derivation) and its defects, Compton effect. de-Broglie hypothesis. Heisenberg uncertainty principle . Hamiltonian Operator.	10

Semester IV, Paper-2 (Practical)
Course Title: Instrumental Analysis

Programme: **Diploma in Chemical Dynamics and Analytical Techniques**	Year: Two	Semester: IV
Practical paper-3		Subject: Chemistry
Course Code: B020402P	**Course Title: Instrumental Analysis**	

Course outcomes: Upon completion of this course, chemistry majors are able to employ critical thinking and scientific inquiry in the performance, design, interpretation and documentation of laboratory experiments, at a level suitable to succeed at an entry-level position in chemical industry or a chemistry graduate program. · 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 IR and NMR spectroscopic techniques

· To develop basic skills required for purification, solvent extraction, TLC and column chromatography

Credits: 2	Elective
Max. Marks: 25 + 75	Min. Passing Marks:

Practical 60 h

Unit	Topics	No of Lectures
I	**Molecular Weight Determination** 1. Determination of molecular weight of a non-volatile solute by Rast method/ Beckmann freezing point method. 2. Determination of the apparent degree of dissociation of an electrolyte (e.g., NaCl) in aqueous solution at different concentrations by ebullioscopy	10
II	**Spectrophotometry** 1. To verify Beer – Lambert Law for $KMnO_4/K_2Cr_2O_7$ and determining the concentration of the given solution of the substance from absorption measurement 2. Determination of pKa values of indicator using spectrophotometry. 3. Determination of chemical oxygen demand (COD).	20

Semester V, Paper-1 (Theory)
Course Title: Organic Synthesis A

Programme: **Degree in Bachelor of Science**	Year: Three	Semester: V
Paper-2 Theory		Compulsory Subject: Chemistry
Course Code: B020501T	Course Title: **Organic Synthesis A**	

Course outcomes: Hydrocarbons are the principal constituents of petroleum and natural gas. They serve as fuels and lubricants as well as raw materials for the production of plastics, fibers, rubbers, solvents and industrial chemicals. This course will provide a broad foundation in for the synthesis of hydrocarbons. Hydroxy and carbonyl compounds are industrially important compounds The industries of plastics, fibers, petroleum and rubbers will specially recognize this course. Students will gain an understanding of which are used as solvents and raw material for synthesis of drug and other pharmaceutically important compounds.

- Synthesis and chemical properties of aliphatic and aromatic hydrocarbons
- Synthesis and chemical properties of alcohols, halides carbonyl compounds, carboxylic acids and esters
- How to design and synthesize aliphatic and aromatic hydrocarbons.
- How to convert aliphatic and aromatic hydrocarbons to other industrially important compounds
- Functional group interconversion.

Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures- = 60

Unit	Topics	No. of Lectures
I	**Chemistry of Alkanes and Cycloalkanes** **A) Alkanes** :Classification of carbon atom in alkanes, General methods of preparation, physical and chemical properties of alkanes: Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity **B) Cycloalkanes:** Nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Chair, Boat and Twist boat forms of cyclohexane with energy diagrams ring strain in small rings, theory of strain less rings. The case of cyclopropane ring, banana bonds.	8
II	**Chemistry of Alkenes** Methods of formation of alkenes, Addition to **C=C:** mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity; reactions: hydrogenation, halogenation, hydrohalogenation, hydration, oxymercuration demercuration, hydroboration-oxidation, epoxidation, *syn* and *anti*-hydroxylation, ozonolysis, addition of singlet and triplet carbenes; Simmons-Smith cyclopropanation reaction; electrophilic	12

Semester-V Paper-2

Course Title: Rearrangements and Chemistry of Group Elements

Programme: Degree in Bachelor of Science	Year: Three	Semester: V
		Paper-2 Theory **Elective** Subject: Chemistry
Course Code: B020502T	**Course Title: Rearrangements and Chemistry of Group Elements**	

Course outcomes: This paper provides detailed knowledge of synthesis of various class of organic compounds and functional groups inter conversion. Organic synthesis is the most important branch of organic chemistry which provides jobs in production & QC departments related to chemicals, drugs, medicines, FMCG etc. industries.

· 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 as well as their extraction. This paper also gives detailed understanding of the s, p, d and f block elements and their characteristics.

Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures- = 60

Unit	Topics	No. of Lectures
I	**Rearrangements** A detailed study of the following rearrangements: Pinacol-pinacolone, Demjanov, BenzilBensilic acid, Favorskii, Hofman, Curtius, Schmidt, Bacyer-Villiger and Frics rearrangement	6
II	**Catalysis** General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts. Phase transfer catalysts, application of zeolites as catalysts. Enzyme catalysis; Michaelis-Menten equation, turn-over number.	8
III	**Chemistry of Main Group Elements**	10

Semester V, Paper-3 (Practical)

Course Title: Qualitative Analysis

Programme: Degree in Bachelor of Science	Year: Three	Semester: V
Practical paper-3 Subject: Chemistry		
Course Code: B020503P	**Course Title: Qualitative Analysis**	

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 mixtures and organic compounds.

- Identification of acidic and basic radicals in inorganic mixtures
- Separation of organic compounds from mixture
- Elemental analysis in organic compounds
- Identification of functional group in organic compounds
- Identification of organic compound

Credits: 2	Elective
Max. Marks: 25+75	Min. Passing Marks:

Practical 60 h

Unit	Topics	No of lectures
I	**Inorganic Qualitative Analysis** Semi micro Analysis – cation analysis, separation and identification of ions from Groups I, II, III, IV, V and VI, Anion analysis. Mixture containing 6 radicals-2 +4 or 4+ or 3+3	16
II	**Elemental analysis and identification of functional groups** Detection of extra elements (N, S and halogens) and functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide) in simple organic compounds.	14
III	**Separation of Organic Mixture** Analysis of an organic mixture containing two solid components using water, $NaHCO_3$NaOH for separation and preparation of suitable derivatives	10
IV	**Identification of organic compounds** Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives. Identification of the organic compounds by IR and PMR Spectroscopy.(Photocopies of the spectra to be provided to the students)	20

Semester-VI Paper-1
Course Title: Organic Synthesis B

Programme: Degree in Bachelor of Science	Year: Three	Semester: VI
Paper-1 Theory **Compulsory** Subject: Chemistry		
Course Code:B020601T	**Course Title: Organic Synthesis B**	

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

· It relates and gives an analytical aptitude for synthesizing various industrially important compounds. · Learn the different types of alkaloids, & terpenes etc and their chemistry and medicinal importance. · Explain the importance of natural compounds as lead molecules for new drug discovery.

Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures- = 60

Unit	Topics	No. of Lectures
I	**Reagents in Organic Synthesis** A detailed study of the following reagents in organic transformations Oxidation with DDQ, CAN and SeO_2, mCPBA, Jones Oxidation, PCC, PDC, PFC, Collin's reagent and ruthenium tetraoxide. Reduction with $NaBH_4$, $LiAlH_4$, Meerwein-Ponndorf-Verley (MPV) reduction, Wilkinson's catalyst, Birch reduction, DIBAL-H	6

Or	
Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	(05 marks)
Course prerequisites: To study this course, a student must have Passed Sem-V Theory paper-1	
Suggested equivalent online courses:	
Further Suggestions:	

Semester-VI Paper-2

Course Title: Chemical Energetics and Radio Chemistry

Programme: **Degree in Bachelor of Science**	Year: Three	Semester: VI
Paper-2 Theory	**Elective Subject**: Chemistry	
Course Code: B020602T	**Course Title: Chemical Energetics and Radio Chemistry**	

Course outcomes: Upon successful completion of this course students should be able to describe laws of thermodynamics and its applications, phase equilibria of one and two component system, electro chemistry ,ionic equilibrium applications of conductivity and potentiometric measurements

Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks:
Total No. of Lectures- = 60	

Unit	Topics	No. of Lectures
I	**Thermodynamics-1 :** **First Law of Thermodynamics** : Statement , definition of internal energy and enthalpy. Heat capacity ,heat capacities at constant volume and pressure and their relationship. Joule's law – Joule Thomson coefficient and inversion temperature . Calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process. **Thermochemistry:** Standard state, standard enthalpy of formation – Hess's law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume . Enthalpy of neutralization . Bond dissociation energy and its calculation from thermo-chemical data , temperature dependence of enthalpy. Kirchhoff's equation.	8

Semester VI, Paper-3 (Practical)
Course Title: Analytical Methods

Programme: Degree in Bachelor of Science	Year: Three	Semester: VI
		Practical paper-3 Subject: Chemistry
Course Code: B020603P	**Course Title: Analytical Methods**	
Course Outcomes: Upon successful completion of this course students should be able to quantify the product obtained through gravimetric **method; determination** of R_f values and identification of organic compounds through paper and thin layer chromatography laboratory techniques: perform thermo chemical reactions		
Credits: 2		Elective
Max. Marks: 25+75		Min. Passing Marks:
		Practical 60 h

Unit	Topics	No of Lectures
I	**Gravimetric Analysis** 1. Analysis of Cu as CuSCN, 2. Analysis of Ni as Ni (dimethylglyoxime) 3. Analysis of Ba as $BaSO_4$.	30
II	**Paper Chromatography** Ascending and Circular. Determination of Rf values and identification of organic compounds: Separation of a mixture of phenylalanine and glycine. Alanine and aspartic acid Leucine and glutamic acid. Spray reagent – ninhydrin. Separation of a mixture of D, L – alanine, glycine, and L-leucine using n-butanol:acetic acid: water (4:1:5). Spray reagent	8

:: Subject Prerequisties::

To study this subject a student must had the subject(s) Mathematics in class 12th

:: Programme Outcomes (POs) ::

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

:: Programme Specific Outcomes (PSOs)::

After completing B.Sc. (with Statistics) the student should have

- Knowledge of different concepts, principles, methodologies and tools (skills) of Statistics.
- Ability to collect, tabulate, represent graphically, analyze and interpret data/information by using appropriate statistical tools.
- Ability to identify and solve a wide range of problems in real life/industry related to Statistics.
- Familiarity with computational techniques and statistical software including programming language (e.g. R) for mathematical and statistical computation.
- Capability to use appropriate statistical skills in interdisciplinary areas such as finance, health, agriculture, government, business, industry, telecommunication and bio-statistics.
- Ability to compete with industrial/private sector demand in the field of data analysis, marketing survey, etc. in professional manner and pursue their future career in the field of Statistics.
- Ability to develop original thinking for formulating new problems and providing their solutions. As a result, they will be able to pursue higher studies or research in the field of Statistics.

Programme/Class: **Certificate**	Year: **First**	Semester: **First**
Subject: **STATISTICS**		
Course Code: **-B060101T**	Course Title: **Descriptive Statistics (Univariate) and Theory of Probability**	

Course outcomes:

After completing this course a student will have:

- ✓ Knowledge of Statistics, its scope and importance in various fields.
- ✓ Ability to understand concepts of sample vs. population and difference between different types of data.
- ✓ Knowledge of methods for summarising data sets, including common graphical tools (such as boxplots, histograms and stem plots). Interpret histograms and boxplots.
- ✓ Ability to describe data with measures of central tendency and measures of dispersion.
- ✓ Ability to understand measures of skewness and kurtosis and their utility and significance.
- ✓ Ability to understand the concept of probability along with basic laws and axioms of probability.
- ✓ Ability to understand the terms mutually exclusive and independence and their relevance.
- ✓ Ability to identify the appropriate method (i.e. union, intersection, conditional, etc.) for solving a problem.
- ✓ Ability to apply basic probability principles to solve real life problems.
- ✓ Ability to understand the concept of random variable (discrete and continuous), concept of probability distribution.

Credits: **04**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

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

Unit	Topic	No. of Lectures
	Part-A: Descriptive Statistics (Univariate)	
I	Introduction to Statistics, Meaning of Statistics, Importance of Statistics, Scope of Statistics in Industry, Introduction and contribution of Indian Scholars in Statistics. Concept of Statistical population, Attributes and Variables (Discrete and Continuous), Different types of scales – Nominal, Ordinal, Ratio and Interval, Primary data – designing a questionnaire and schedule, collection of primary data, checking their consistency, Secondary data.	**06**
II	Presentation of data : Classification, Tabulation, Diagrammatic & Graphical Representation of Grouped data, Frequency distributions, Cumulative frequency distributions and their graphical representations, Histogram, Frequency polygon and Ogives, Stem and Leaf plot, Box Plot.	**08**
III	Measures of Central tendency and Dispersion and their properties, Merits and Demerits of these Measures.	**10**

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Quiz/ Assignment	(05 marks)
Class Test-I	(10 marks)
Class Test-II	(10 marks)

This course can be opted as a minor elective by the students. Open to all (Other Faculty)

Programme/Class: **Certificate**	Year: **First**	Semester: **First**
Subject: **STATISTICS**		
Course Code: -**B060102P**	Course Title: **Descriptive Data Analysis Lab (Univariate)**	

Course outcomes:
After completing this course a student will have:

- ✓ Ability to represent/summarise the data/information using appropriate Graphical methods including common graphical tools (such as boxplots, histograms and stem plots) and also to draw inferences from these graphs
- ✓ Acquire the knowledge to identify the situation to apply appropriate measure of central tendency as per the nature and need of the data and draw meaningful conclusions regarding behavior of the data.
- ✓ Acquire the knowledge to identify the situation to apply appropriate measure of dispersion as per the nature and need of the data and draw meaningful conclusions regarding heterogeneity of the data.
- ✓ Ability to measure skewness and kurtosis of data and define their significance.
- ✓ Acquire the knowledge to compute conditional probabilities based on Bayes Theorem.

Credits: **02**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....
Total No. of Lectures-Tutorials-Practical (in hours per week): **0-0-4.**	

	List of Practicals	No. of Lectures
	1. Problems based on graphical representation of data by Histogram, Frequency polygons, frequency curves and Ogives, Stem and Leaf Plot, Box Plot. 2. Problems based on calculation of Measures of Central Tendency. 3. Problems based on calculation of Measures of Dispersion. 4. Problems based on calculation of Moments, Measures of Skewness and Kurtosis. 5. Computation of conditional probabilities based on Bayes theorem	**60**

Programme/Class: **Certificate**	Year: **First**	Semester: **Second**
Subject: **STATISTICS**		
Course Code: **-B060201T**	Course Title: **Descriptive Statistics (Bivariate) and Probability Distributions**	

Course outcomes:

After completing this course a student will have:

- ✓ Knowledge of the method of least squares for curve fitting to theoretically describe experimental data with a function or equation and to find the parameter sassociated with the model.
- ✓ Knowledge of the concepts of correlation and simple linear regression and Perform correlation and regression analysis.
- ✓ Ability to interpret results from correlation and regression.
- ✓ Ability to compute and interpret rank correlation. .
- ✓ Ability to understand concept of qualitative data and its analysis.
- ✓ Knowledge of discrete distributions. Discuss appropriate distribution negative binomial, Poisson, etc. with their properties and application of discrete distribution models to solve problems.
- ✓ Knowledge of continuous distributions. Discuss the appropriate distribution (i.e. uniform, exponential, normal, etc.) with their properties and application of continuous distribution models to solve problems.
- ✓ Knowledge of the formal definition of order statistics.
- ✓ Ability to identify the application of theory of order statistics in real life problems.

Credits: **04**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

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

Unit	Topic	No. of Lectures
	Part-A: Descriptive Statistics (Bivariate)	
I	Bivariate data, Principles of least squares, Most plausible values, Meaning of curve fitting, Fitting of straight line, parabola, logarithmic, power curves and other simple forms by method of least squares.	**08**
II	Bi-variate frequency table, Correlation, Types of relationships, Scatter diagram, Karl-Pearson's Correlation Coefficient and its properties.	**08**
III	Spearman Rank correlation and its coefficient, Regression analysis through both types of regression equations for X and Y variables.	**08**
IV	Attributes: Notion and Terminology, Contingency table, Class frequencies and Ultimate class frequencies, Consistency, Association of Attributes, Independence, Measures of association for 2X2 table, Chi-square and Karl Pearson's Coefficient of Association.	**06**

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Quiz/ Assignment	(05 marks)
Class Test-I	(10 marks)
Class Test-II	(10 marks)

This course can be opted as a minor elective by the students. Open to all (Other Faculty)

Programme/Class: **Certificate**	Year: **First**	Semester: **Second**
Subject: **STATISTICS**		
Course Code: **-B060202P**	Course Title: **Descriptive Data Analysis Lab (Bivariate)**	

Course outcomes:
After completing this course a student will have:

1. Ability to deal with the problems based on fitting of curves by Method of least squares e.g. fitting of straight line, second degree polynomial, power curve, exponential curve etc.
2. Ability to deal with problems based on determination of Regression lines and calculation of Correlation coefficient – grouped and ungrouped data.
3. Ability to deal with the problems based on determination of Rank correlation.
4. Ability to fit Binomial and Poisson distribution for given data.

Credits: **02**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

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

	Topic	No. of Lectures
	1. Problems based on fitting of curves by Method of least squares e.g. fitting of straight line, second degree polynomial, power curve, exponential curve etc. 2. Problems based on determination of Regression lines and calculation of Correlation coefficient – grouped and ungrouped data. 3. Problems based on determination of Rank correlation. 4. Fitting of Binomial and Poisson distribution.	**60**

Suggested Readings:
As suggested for paper code B060201T.

Programme/Class: **Diploma**	Year: **Second**	Semester: **Third**
Subject: **STATISTICS**		
Course Code: **-B060301T**	Course Title: **Theory of Estimation and Sampling Survey**	

Course outcomes:

After completing this course a student will have:

- ✓ Knowledge of the concept of Sampling distributions.
- ✓ Ability to understand the difference between parameter & statistic and standard error & standard deviation.
- ✓ Knowledge of the sampling distribution of the sum and mean.
- ✓ Ability to understand the t, f and chi-square distribution and to identify the main characteristics of these distributions.
- ✓ Knowledge of the concept of Point and Interval Estimation and discuss characteristics of a good estimator.
- ✓ Ability to understand and practice various methods of estimations of parameters.
- ✓ Ability to understand the concept of sampling and how it is different from complete enumeration.
- ✓ Knowledge of various probability and non-probability sampling methods along with estimates of population parameters
- ✓ Ability to identify the situations where the various sampling techniques shall be used.
- ✓ Knowledge of sampling and non-sampling errors.

Credits: **04**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

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

Unit	Topic	No. of Lectures
	Part-A: Sampling Survey	
I	Types of population, Sample, Principal Steps in Sample Survey, Benefit of Sampling Survey, Sampling vs. Complete enumeration: Sampling units and Sampling frame, Precision and efficiency of estimators. Types of Sampling Methods: Probability Sampling, Non-Probability Sampling: Convenience, Purposive, Quota, Voluntary and Snowball Sampling.	06
II	Simple Random sampling with and without replacement, Use of random number tables in selection of simple random sample, Estimation of population mean and proportion, Derivation of expression for variance of these estimators, Estimation of variances.	08
III	Stratified random sampling, Problem of allocation, proportional allocation, optimum allocation. Derivation of the expressions for the standard error of the usual estimators when these allocations are used. Comparison between SRS & Stratified Sampling in terms of Variance	08

Programme/Class: **Diploma**	Year: **Second**	Semester: **Third**
Subject: **STATISTICS**		
Course Code: **-B060302P**	Course Title: **Sampling Techniques Lab**	

Course outcomes:

After completing this course a student will have:

1. Ability to draw a simple random sample with the help of table of random numbers.
2. Ability to estimate population means and variance in simple random sampling.
3. Ability to deal with problems based on Stratified random sampling for population means (proportional and optimum allocation).
4. Ability to deal with problems based on Systematic random sampling

Credits: **02**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

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

	Topic	No. of Lectures
	1. Problems based on drawing a simple random sample with the help of table of random numbers. 2. Problems based on estimation of population means and variance in simple random sampling. 3. Problems based on Stratified random sampling for population means (proportional and optimum allocation). 4. Problems based on Systematic random sampling	**60**

Suggested Readings:

As suggested for paper code B060301T.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Practical File/Record, Class Activities and Overall performance. The marks shall be as follows:

Practical File/Record	(10 marks)
Class Interaction	(05 marks)
Report Preparation/ Presentation	(10 marks)

Suggested Practical Examination Evaluation Methods: (75 Marks)

Practical Examination Evaluation shall be based on Viva-voce and Practical Exercises. The marks shall be as follows:

Practical Exercise (Major) 01 x 25 Marks	**25 Marks**
Practical Exercise (Minor) 02 x 15 Marks	**30 Marks**
Viva-voce	**20 Marks**

There shall be 04-05 Practical Exercises in Examination comprising 01 as Major (Compulsory) and 03-04 as Minor (Students have to attend any 02).

Course prerequisites: To study this course, a student must have opted/passed the paper code **B060301T.**

Further Suggestions:

In practical classes a series of lectures for any statistical software may be organized for students and they may be asked to use it to perform practical problems assigned to them.

Programme/Class: **Diploma**	Year: **Second**	Semester: **Fourth**
Subject: **STATISTICS**		
Course Code: **-B060401T**	Course Title: **Testing of Hypothesis and Applied Statistics**	

Course outcomes:

After completing this course a student will have:

- ✓ Knowledge of the terms like null and alternative hypotheses, two-tailed and one-tailed alternative hypotheses, significant and insignificant, level of significance and confidence, p value etc.
- ✓ Ability to understand the concept of MP, UMP and UMPU tests
- ✓ Ability to understand under what situations one would conduct the small sample and large sample tests (in case of one sample and two sample tests).
- ✓ Familiarity with different aspects of Applied Statistics and their use in real life situations.
- ✓ Ability to understand the concept of Time series along with its different components.
- ✓ Knowledge of Index numbers and their applications along with different types of Index numbers.
- ✓ Familiarity with various demographic methods and different measures of mortality and fertility.
- ✓ Ability to understand the concept of life table and its construction.
- ✓ Knowledge to understand the concept of statistical quality control and different control charts for variables and attributes.

Credits: **04**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

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

Unit	Topic	No. of Lectures
	Part-A: Testing of Hypothesis and Tests of Significance	
I	Statistical Hypothesis (Simple and Composite), Testing of hypothesis. Type –I and Type – II errors, Significance level, p-values	08
II	Neyman-Pearson Lemma, Power of a test, Definitions of Most Powerful (MP), Uniformly Most Powerful (UMP) and Uniformly Most Powerful Unbiased (UMPU) tests.	08
III	Test of significance: Large sample tests for (Attributes and Variables) proportions and means (i) for one sample (ii) for two samples.	06
IV	Small sample test based on t, F and chi-square distributions.	08

Programme/Class: **Diploma**	Year: **Second**	Semester: **Fourth**
Subject: **STATISTICS**		
Course Code: **-B060402P**	Course Title: **Tests of Significance and Applied Statistics Lab**	

Course outcomes:

After completing this course a student will have:

1. Ability to conduct test of significance based on t , F tests and Chi-square test.
2. Ability to deal with problems based on large sample tests.
3. Ability to deal with problems based on time series and calculation of its different components for forecasting.
4. Ability to deal with problems based on Index number.
5. Acquire knowledge about measurement of mortality and fertility.
6. Ability to deal with problems based on life table.
7. Ability to work with control charts for variables and attributes and draw inferences.

Credits: **02**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

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

	Topic	No. of Lectures
	1. Problems based on t – test. 2. Problems based on F-test. 3. Problems based on Chi-square test. 4. Problems based on calculation of power function. 5. Problems based on large sample tests. 6. Problems based on time series and its different components 7. Problems based on Index number. 8. Problems based on measurement of mortality and fertility. 9. Problems based on life table. 10. Problems based on control charts for variables and attributes.	**60**

Programme/Class: **B.Sc.**	Year: **Third**	Semester: **Fifth**
Subject: **STATISTICS**		
Course Code:-**B060501T**	Course Title: **Multivariate Analysis and Non-parametric Methods**	

Course outcomes:

After completing this course a student will have:

- ✓ Ability to understand the basic concepts of matrices in order to study multivariate distribution.
- ✓ Ability to understand bivariate normal distribution and its applications
- ✓ Knowledge of the applications of multivariate normal distribution and Maximum Likelihood estimates of mean vector and dispersion matrix.
- ✓ Ability to apply distribution free tests (Non-parametric methods) for one and two sample cases.

Credits: **04**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

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

Unit	Topic	No. of Lectures
I	Elementary operations on Matrices, Rank of Matrix, Row and Column Rank, Inverse of a matrix. Eigen values and Eigen vectors.	08
II	Introduction to multivariate analysis, Uses and applications of multivariate analysis, Bivariate normal distribution: definition and Simple properties.	07
III	Multivariate Normal Distribution, Marginal and Conditional Distributions, Characteristics functions	08
IV	Maximum Likelihood Estimation of Mean vector and Dispersion matrix and their Independence sufficient statistics of these estimates.	07
V	Concepts and definitions of Multiple and Partial correlations and Multiple Regressions for three variables only (with their practical applications)	08
VI	Non-parametric tests, Tests for location and symmetry, One sample tests: Sign test, Wilcoxon Signed rank tests.	07
VII	Tests for randomness: Run test, Test for goodness of fit.	07
VIII	Two sample tests: Median Test, Kolmogorov – Smirnov's test and Mann-Whitney U test.	08

Programme/Class: **B.Sc.**	Year: **Third**	Semester: **Fifth**
Subject: **STATISTICS**		
Course Code: **-B060502T**	Course Title: **Analysis of Variance and Design of Experiment**	

Course outcomes:

After completing this course a student will have:

- ✓ Knowledge of the concept of Analysis of Variance (ANOVA).
- ✓ Ability to carry out the ANOVA for One way and Two way Classification.
- ✓ Ability to carry out the post-hoc analysis.
- ✓ Knowledge of the concept of Design of experiment and its basic principles.
- ✓ Ability to perform the basic symmetric designs CRD, RBD and LSD with and without missing observations.
- ✓ Knowledge of the concept of factorial experiments and their practical applications.

Credits: **04**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

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

Unit	Topic	No. of Lectures
I	Definition of Analysis of Variance, Assumptions and Limitations of ANOVA, One way classification.	08
II	Two way classification with one observation per cell. Multiple comparison tests using critical difference criteria.	08
III	Principles of Design of Experiment: Randomization, Replication and Local Control, Choice of size and type of a plot using uniformity trials.	07
IV	Completely Randomized Design (CRD), Concept and definition, statistical analysis of CRD, Merits and demerits.	07
V	Randomized Block Design (RBD), Concept and definition of efficiency of design, Comparison of efficiency between CRD and RBD.	07
VI	Latin Square Design (LSD), Lay-out, ANOVA table, Comparison of efficiencies between LSD and RBD; LSD and CRD	08
VII	Missing plot technique: Estimation of missing plots by minimizing error sum of squares in RBD and LSD with one missing observation.	07
VIII	Factorial Experiments: General description of factorial experiments, 2^2, 2^3 and 2^n factorial experiments arranged in RBD and LSD, Definition of Main effects and Interactions in 2^2 and 2^3 factorial experiments,	08

Programme/Class: **B.Sc.**	Year: **Third**	Semester: **Fifth**
Subject: **STATISTICS**		
Course Code: **-B060503P**	Course Title: **Non-parametric Methods and DOE Lab**	

Course outcomes:

After completing this course a student will have:

1. Ability to conduct test of significance based non-parametric tests.
2. Ability to deal with multivariate data.
3. Ability to perform ANOVA for one way and two classification.
4. Ability to perform post-hoc analysis.
5. Ability to conduct analysis of CRD, RBD and LSD with and without missing observations.

Credits: **02**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

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

	Topic	No. of Lectures
	1. Problems based on Non-parametric tests for one sample. 2. Problems based on Non-parametric tests for two samples. 3. Problems based on Rank and Inverse of a matrix. 4. Problems based on Mean vector and Dispersion matrix of a multivariate normal distribution. 5. Problems based on Analysis of variance in one-way and two-way classification. 6. Problems based on Analysis of a Latin square design. 7. Problems based on Analysis of variance in RBD and LSD with one missing observation.	**60**

Programme/Class: **B.Sc.**	Year: **Third**	Semester: **Sixth**
Subject: **STATISTICS**		
Course Code: **-B060601T**	Course Title: **Statistical Computing and Introduction to Statistical Software**	

Course outcomes:

After completing this course a student will have:

- ✓ Basic Knowledge of Excel and R programming with some basic notions for developing their own simple programs and visualizing graphics in R and Excel.
- ✓ Ability to perform data analysis for both univariate and multivariate data sets using R as well as Excel.

Credits: **04**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

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

Unit	Topic	No. of Lectures
I	Introduction to Computer: Generation of Computer,Basic Structure of Computer, Digital computer and its peripherals, number systems (Binary, Octal, Hexadecimal Systems). Flow chart for simple statistical problems.	**08**
II	Solid Understanding of Basics Excel:- Getting Start with Excel, Working with Cell and Ranges, Data Entry & Editing, Number formatting, delete, insert and adjust cells, columns and rows, Preview and print workbook.	**06**
III	Custom Fill, Autofill, Flash Fill, Date & Time, Data Formatting, Sort & Filter, Grouping Sheets, Managing worksheets- Changing Name, Colour, Add, Delete, Hide/Unhide, Worksheet Views- Comparing Sheet Side by Side, Splitting Sheet into Panes, freezing Panes,	**06**
IV	Using Excel: Basic Mathematical functions, Graphs, Descriptive Statistics, Analysis of Variance (One-way & Two way ANOVA), Karl Pearson correlation coefficient, Regression Analysis.	**10**
V	Introduction to R Programming and R Studio, Installing R, R as a calculator. Creating a data set, Understanding a data set, Data structure: Vectors, Matrices, Arrays, Data Frames, Factors and Lists	**08**
VI	Data inputs: Entering data from the keyboard, Importing Data, creating new variables, recoding variable, renaming variables,	**07**
VII	Graphs using R, Inferential Statistics- Parametric test: Test for Normality, t-test for single mean, t-test for difference between means, paired t-test.	**08**
VIII	Using R: Wilcoxon signed rank sum test, Mann Whitney U test, Kolmogorov-Smirnov Test for normality, Analysis of Variance (One- way & Two way ANOVA), Karl Pearson correlation coefficient, Regression Analysis.	**07**

Programme/Class: **B.Sc.**	Year: **Third**	Semester: **Sixth**
Subject: **STATISTICS**		
Course Code: **-B060602T**	Course Title: **Operations Research**	

Course outcomes:

After completing this course a student will have:

- ✓ An idea about the historical background and need of Operations research.
- ✓ Ability to identify and develop operational research models from the verbal description of the real life problems.
- ✓ Knowledge of the mathematical tools that are needed to solve optimization problems.
- ✓ Ability of solving Linear programming problem, Transportation and Assignment problems, Job sequencing, etc.
- ✓ Ability to solve the problems based on Game Theory.

Credits: **04**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

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

Unit	Topic	No. of Lectures
I	History & background of OR, Applications and uses of OR in different fields, General linear programming problems and their formulations.	**06**
II	Solving LPP by Graphical Method Solving LPP by Simplex method.	**10**
III	Method Solving LPP by Big–M method and Two phase Method.	**08**
IV	Transportation problem: North-west corner rule, Least cost method, Vogel's approximation method. Optimum solution: Modi method.	**10**
V	Assignment Problem: Hungarian Method, Travelling Salesman Problem,	**06**
VI	Job sequencing: n jobs – 2 machines, n jobs – k machines, 2 jobs – n machines.	**06**
VII	Game theory: Introduction, Competitive Situations, Characteristics of Competitive Games. Rectangular game, Two-Person Zero-Sum game, minimax-maximin principle, Solution to rectangular game using graphical method	**08**
VIII	Dominance rule to reduce the game matrix and solution of Payoff matrix with mixed strategy.	**06**

Programme/Class: **B.Sc.**	Year: **Third**	Semester: **Sixth**
Subject: **STATISTICS**		
Course Code: -**B060603P**	Course Title: **Operations Research and Statistical Computing Lab**	

Course outcomes:

After completing this course a student will have:

1. Knowledge of mathematical formulation of L.P.P
2. Ability of solving LPP using different methods.
3. Ability to solve Allocation Problem based on Transportation and Assignment models.
4. Ability to solve problems based on Game Theory.
5. Ability to use programming language R as Calculator.
6. Knowledge of using R in simple data analysis.
7. Able to perform statistical functions, creating graphs and statistical analysis by using Excel.

Credits: **02**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

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

	Topic	No. of Lectures
	1. Problem based on Mathematical formulation of L.P.P 2. Problem based on solving LPP using Graphical Method 3. Problem based on solving LPP using Simplex Method 4. Problem based on solving LPP using Big Mmethod involving artificial variables. 5. Allocation Problem based on Transportation model. 6. Allocation Problem based on Assignment model. 7. Problems based on Game payoff matrix. 8. Problem based on solving Graphical solution to mx2/ 2xn rectangular game. 9. Problem based on solving Mixed strategy game. 10. Problem based on application of R as Calculator. 11. Problem based on application of R in simple data analysis 12. Problem based on application of Excel in data analysis	60

Open Elective courses for UG programmes as an optional

To be opted in First/ Third Odd Semester

Course prerequisites: To study this course, a student must have the subject **Mathematics/Elementary Mathematics in class 10th.**
This course can be opted as a minor elective by the students. **Open to all (Other Faculty)**

Syllabus of the course

Programme/Class: **Certificate**	Year: **First**	Semester: **First**
Subject: **STATISTICS**		
Course Code: **-B060103T**	Course Title: **Basic Statistics**	

Course outcomes:

After completing this course a student will have:

- ✓ Ability to understand concepts of collecting Primary and Secondary data.
- ✓ Knowledge of methods for summarizing data sets, including common graphical tools(such as boxplots, histograms etc.). Interpret histograms and boxplots.
- ✓ Ability to describe data with measures of central tendency and measures of dispersion.
- ✓ Ability to understand the concept of probability along with basic laws and axioms of probability.
- ✓ Ability to understand the terms mutually exclusive and independence and their relevance.
- ✓ Ability to identify the appropriate method (i.e. union, intersection, conditional, etc.) for solving a problem.
- ✓ Ability to apply basic probability principles to solve real life problems.
- ✓ Ability to understand the concept of random variable (discrete and continuous), concept of probability distribution.
- ✓ Knowledge of the concepts of correlation and simple linear regression and Perform correlation and regression analysis.
- ✓ Ability to interpret results from correlation and regression

Credits: **04**	Core: Minor Elective
Max. Marks: **25+75**	Min. Passing Marks: .....
Total No. of Lectures-Tutorials (in hours per week): **04**	

Part-A: Basic Statistics

Unit	Topic	No. of Lectures
I	Primary and Secondary data and their collection, Types of classification: Chronological, Geographic, Qualitative and Quantitative, Construction of frequency distributions, Cumulative frequency distribution.	06

B.A. Economics

The Course is designed for the students pursuing graduation with Economics in regular mode. The programme aims to inculcate economic thinking among the students in economic decision making by comprehending economic theory. It aims to develop analytical view point in the students about the economic behaviour of people. The objective is to nurture among student a view point of a socially responsible and ethical aware citizen. The under graduate programme will have 10 courses in 6 Semesters in 3 years. In the Fifth and the Sixth Semester 01 paper is given as optional. In the Fifth Semester it is proposed to have Dissertation/Project keeping in the spirit of the New Education Policy 2020 to introduce research at the graduation level. The structure of syllabus is based on the template of UGC proposed for the CBCS for undergraduates in Economic (Regular).

Programme Specific Outcomes (PSOs)- Student after completing graduation will be able to learn-

PSO 1: The behavioural patterns of different economic agents, advance theoretical issues and their applications.
PSO 2: Understand the basic concept of microeconomics.
PSO 3: Understanding basic concepts of Macroeconomics.
PSO 4: Acquaint with some basic statistical methods to be applied in economics.
PSO 5: Acquaint with some basic mathematical methods to be applied in economics.
PSO 6: Acquaint with some basic theoretical concept of public finance.
PSO 7: Acquaint with the measurement of development with the help of theories along with the conceptual issues of poverty and inequalities with Indian perspectives.
PSO 8: Delineate the fiscal policies designed for developed and developing economics.
PSO 9: Facilitate the historical developments in the economic thoughts propounded by different schools. To familiarise students with the contribution of Indian Economic Thinkers and the relevance of their contribution.
PSO 10: Learn the basic concept of monetary analysis and financial marketing in Indian financial markets.
PSO 11: Learn the development issues of Indian economy.
PSO 12: Acquaint with some basic concept of environmental economics along with the solution of the environmental problems.
PSO 13: Learn the real and monetary sides of International economics.
PSO 14: Familiarise and acquaint with the characteristics of the economy of Uttar Pradesh.
PSO 15: To familiarize the students about issues of ethics in economic thinking and practice.

List of Papers in all Six semesters

Year	Sem.	Course Code	Paper Title	Theory/ Practical	Credits
1	I	A080101T	Principle of Micro Economics	Theory	6
1	II	A080201T	Principles of Macro Economics	Theory	6
2	III	A080301T	History of Economic Thought	Theory	6
2	IV	A080401T	Money, Banking and Public Finance	Theory	6
3	V	A080501T	Economic Growth and Development	Theory	5
3	V	A080502T/ A080503T	**Optional Paper (Any one)** Environmental Economics *or* International Economics	Theory	5
3	V	A080504R	Elementary Statistics based Project	Practical	3
3	VI	A080601T	Indian Economy & Economy of Uttar Pradesh	Theory	5
3	VI	A080602T/A080603T	**Optional Paper (Any one)** Agriculture Economics or Elcmentary Mathematics	Theory	5
3	VI	A080604R	Dissertation/Project on the Local Issues with Economic Focus plus Presentation on PPT of the Dissertation	Project	3
				Total Credit	50

Programme/Class: Degree/ BA	Year: First	Semester: First
	Subject: Economics	
Course Code: A080101T	Course Title: Principle of Micro Economics	

Course Outcome:

- The students are familiarized with basic concepts of microeconomics such as laws of demand and supply and elasticity etc so that he/she can comprehend them & familiarize with day today happenings.
- The students learn and understand the concepts of consumer behaviour like cardinal utility and ordinal utility analysis.
- The students learn and understand application of Indifference curve analysis in deriving demand curves, price effect, income effect and substitution effect.
- The students learn and understand the Theory of production- iso-quants, laws of returns to scale, law of variable proportion.
- The students learn, understand and compare between the Traditional and modern theory of cost.
- Demonstrate an understanding, usage and application of basic economic principles.
- Describe and apply the methods for analyzing consumer behavior through demand and supply, elasticity and marginal utility.
- To analyze the behavioral patterns of different economic agents regarding profit, price, cost etc.
- The decision-making process in different market situations such as perfect competition, monopolistic competition, monopoly and oligopoly markets.
- To deal with the advance theoretical issues and their practical applications of distribution the
- General equilibrium, economic efficiency and market failure.

BA 1st Year, Semester II, Course I (Theory)

Course Code: A080201T
Course Title: Macro Economics

Program/Class: Degree/BA	Year: First	Semester: Second
Subject: Economics		
Course Code:	Course Title: Macro Economics	
Course Learning Outcomes • Students are able to explain national income, comprehend calculation methods of national income, and concepts related to national income. • Students are able to comprehend classical theory of employment and the Keynesian approach. • Students are able to comprehend the concept of multiplier and it's working. • Students are able to understand the relationship between inflation and employment. • Students are able to relate factors determining national income such as consumption, saving and investment. • Students are able to analyze different phases of trade cycle, demonstrate various trade cycle theories, understand the impact of cyclical fluctuation on the growth of business, and lay policies to control trade cycle.		
Credits: 6	Core Compulsory	
Max. Marks: -25+75	Min. Passing Marks:40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w		

Unit	Topics
I	**Basic Concepts**: Nature and scope of macroeconomics, macroeconomic variables: stock and flow concept
II	**Circular flow of income:** Circular flow of income in two-sector, three-sector and four-sector economy
III	**National Income:** Meaning, and concepts of national income; measurement of national income- expenditure approach, production (value-added) approach, and income approach, problems in measurement of national income, concept of per capita national income
IV	**Unemployment**- Meaning of unemployment; labour force participation rate and unemployment rate, types of unemployment- disguised, cyclical, frictional and structural unemployment; Natural rate of unemployment
V	**Inflation**- meaning and types of inflation, cost-push vs demand-pull inflation; headline vs core inflation; wholesale price index vs consumer price index, Phillips curve
VI	**Classical Doctrine and Keynesian Economies:** Tenets of classical economics, Say's Law of market, criticisms of Say's law by Keynes, salient features of Keynesian economics, principle of effective demand
VII	**Consumption and Investment:** Consumption function- average and marginal propensity to consume, determinants of consumption expenditure; investment-

BA 2nd Year, Semester III, Course I (Theory)

Course Code: A080301T
Course Title: History of Economic Thought

Programme/Class: Degree/BA	Year: Second	Semester: Third
Subject: Economics		
Course Code: A080301T	Course Title: History of Economic Thought	

Course outcomes:

- To learn and discuss, at an advanced undergraduate level, how the economic thought has evolved over time.
- Introducing students to the critical comparison of the contributions of the main schools of economics.
- To introduce & highlight before the students about Indian Economic Thinkers and their valuable contribution in the field of Economics.
- The classical, the marginalize revolution and its application to the theories of general and partial equilibrium, the current macroeconomic debate between the neo-classical and the Keynesian school.

Credits: 6	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w	

Unit	Topics
I	**Ancient Economic Thought:** Plato, Aristotle and Kautilya
II	**Mercantilism**: Salient features, factors responsible for growth of mercantilism **Physiocracy:** Salient features, factors responsible for rise of physiocracy
III	**Classical thought:** Adam Smith, David Ricardo and Thomas Malthus
IV	**Marxian Economics-** Economic ideas of Karl Marx
V	**Neo-classical thought:** Marshall, Pigou, Walrus, Jevons and Menger
VI	**Cambridge and Chicago School of thought:** Joan Robinson, Milton Friedman
VII	B.R. Ambedkar, M.K. Gandhi, J.L. Nehru, Chaudhary Charan Singh
VIII	Amartya Sen, J. Bhagwati, Abhijit Banerjee

Suggested Readings:

1. Bhatia,H.L : History of Economic Thought ,Vikash Publishing House.
2. Blackhouse,R (1985) : A History of Modern Economic Analysis, Basil Blackwell, Oxford.
3. Ganguli, B.N(1977) : Indian Economic Thought : A 19th Century Perspective, Tata Mcgraw Hill.
4. Hajela,T.N (2011) : AarthikVicharon Ka Itihas , Ane Books.
5. Hajela,T.N (2011) : History Of Economic Thought , Ane Books.
6. Hunt,E.K&Lautzenheiser,Mark (2011) : History of Economic Thought: A Critical Perspective , Phi Learning.

BA 2nd Year, Semester IV, Course I (Theory)

Course Code: A080401T
Course Title: Money, Banking and Public Finance

Programme/Class: Degree/BA	Year: Second	Semester: Fourth
Subject: Economics		
Course Code: A080401T	Money, Banking and Public Finance	

Course outcomes:

- Understand simple concepts related with monetary economics and banking theory.
- Correlate and apply to current events & key models and concepts of monetary economics and banking theory.
- Appreciate the potential importance of monetary phenomenon in the economy.
- Understand the sources of finance both public and private
- Demonstrate the role of government to correct market failures and possible advantage of public financing.
- Understand the possible burden, benefits and distribution of various types of taxes among various classes of people, know the general trend and impact on general welfare and arouse them to suggest good and bad tax system.

Credits: 6	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:40
Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w	

Unit	Topics
I	**Money:** Meaning, functions and classification of money; demand for money- determinants of demand for money
II	**Supply of money-** Narrow and broad concept of supply of money, high-powered money and money multiplier
III	**Commercial Banks-** Meaning, classification, and functions; liabilities and assets of a commercial bank; credit creation by commercial banks
IV	**Central Bank:** Meaning and functions of a central bank; monetary policy- meaning, instruments and objectives of monetary policy
V	**Public Finance-** Nature and scope of public finance; public finance vs private finance; role of government; functions of public finance, revenue account vs capital account
VI	**Public Revenue:** Major sources of public revenue; canons of taxation; impact and incidence of a tax; effects of taxation
VII	**Public Expenditure:** Meaning and types of public expenditure, causes of rise in public expenditure in India
VIII	**Public Debt and Fiscal Policy:** Meaning and classification of public debt, public debt management; Fiscal policy- meaning, instruments and objectives of fiscal policy

BA 3rd Year, Semester V, Course I (Theory)

Course Code: A080501T
Course Title: Economic Growth and Development

Programme/Class: Degree/BA	Year: Third	Semester: Fifth
Subject: Economics		
Course Code: A080501T	Course Title: Economic Growth and Development	

Course outcomes:

- Students should be able to comprehend the concept and meaning of economic growth and economic development.
- Students should be able to distinguish between economic growth and economic development.
- Students should be able to comprehend the issues and challenges in economic growth and development.
- Students should be able to comprehend and explain the concept of poverty and human development & the related concepts.
- Students should be familiar with the approaches to development.
- Students should be able to understand and explain the factors and variable of economic development.
- Students are able to understand how international factors facilitate and impede economic development.

Credits: 5	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): P- 2/w	

Unit	Topics
I	**Economic Growth**: Meaning of economic growth, determinants of economic growth-physical capital, human capital and technology; factors contributing to a healthy economic climate; concept of inclusive growth
II	**Economic Development**- Meaning of economic development, economic development vs economic growth, concept of sustainable development, sustainable development goals
III	**Comparative Economic Development**: World Bank's income classification of countries, UNDP's Human Development Index, salient features of underdeveloped, developing and developed countries
IV	**Stages of Economic Growth:** Karl Marx's stages of economic growth, Rostow's stages of economic growth
V	**Theories of Economic Growth-I:** Classical theory of economic growth; Marxian theory of economic growth; Harrod-Domar models of economic growth
VI	**Theories of Economic Growth-II:** Nelson's low-level equilibrium trap, Arrow's learning by doing, models of economic growth by Meade and Robinson
VII	**Theories of Economic Development:** Balanced vs unbalanced growth, Lewis theory of unlimited supply of labour, Rosenstein-Rodan's theory of big push; Leibenstein's

BA 3rd Year, Sem. V Course II
(Optional)(Theory)

Programme/Class: Degree/BA	Year: Third	Semester: Fifth
Subject: Economics		
Course Code: A080502T	Course Title: Environmental Economics	

Course outcomes:

- Students should be familiar with the basic concepts of ecology environment and economy.
- Students to understand the solution to environmental problems- the command and control approach, market based methods, tax tradable pollution permit, etc, carbon trading
- Students should be familiar with the concept of Sustainable development, environmental impact assessment CO 5: Global and local environmental concerns.
- Students should be comprehend the Local Issues of Economic Bearing related to environment & development.
- Students should realize the importance and influence of environment on the economy including the quality of manpower.
- Students should realize the importance to make cleaner environment so as to achieve harmonious development.
- Students should comprehend that environmental problem is not the problem of a single country or region but a global problem/issue.
- Demonstrate an awareness of economic growth problems, issues in globalisation, and provide grounding in major growth strategies and development.

Credits:5	Core Compulsory
Max.Marks:25+75	Min.PassingMarks:40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-4/w	

Unit	Topics	No. of Lectures
I	**Introduction:** Key environmental issues and problems, economic way of thinking about these problems, basic concepts from economics; Pareto optimality and market failure in the presence of externalities; property rights and other approaches.	10
II	**The Design and Implementation of Environmental Policy:** Overview, Pigouvian taxes and effluent fees, tradable permits, implementation of environmental policies in India and international experience; trans-boundary environmental problems; economics of climate change, Kuznets Curve.	10
III	**Environmental Valuation Methods and Applications:** Valuation of non-market goods and services-theory and practice; measurement methods; cost-benefit analysis of environmental policies and regulations.	10
IV	**Sustainable Development:** Concepts; measurement; perspectives from Indian experience.	7
V	**The Theory of Externality:** Positive & Negative Externality; Public Goods; Private Goods; Public Bads; Market Failure and Pigouvian Solution- Pigouvian Tax.; Coase's Theorem and Property Rights; Eco-Labelling; Eco-Efficiency.	8
VI	**Social Limits to Growth Model:** Green Accounting; Environmental Valuation- Meaning, Need for Environmental Valuation, Methods of Environmental Valuation; Difficulty in Measuring Environmental Values, Environmental Damages and Its Valuation.	10
VII	**Indian Constitution and the Environment:** Environmental Management-Meaning and Concept, Objectives and Goals, Obstacles; Environmental Impact Assessment; Environmental Education and Awareness-Dilemma of Environmental Ethics and Practical Problems, Environmental Education in India.	10
VIII	**Population and Environment:** Trade and Environment in the WTO Regime; Climate Change- Meaning and Concept, Ozone Depletion, Acid Rain, Global Warming and Greenhouse Effect; Indian Environmental Issues and Legislations; Role of Judiciary in Environmental Protection and Conservation; International Environmental Issues and Legislations, Carbon Trading.	10

BA 3rd Year, Semester V, Course II (Theory) Optional

Programme/Class: Degree/BA	Year: Third	Semester: Fifth
Subject: Economics		
Course Code: A080503T	Course Title: International Economics	

Course outcomes:

- Students should be able to understand and explain the concept, need, significance and scope of international economics.
- Students should be familiar with the approaches of international trade
- Students should be familiar with and are able to explain the economic integration at the global level and the formation of groups.
- Students are familiar with the international organizations and their objectives. Students should be able to analyse the importance and relevance of these international organizations.

Credits:5	Core Compulsory
Max.Marks:25+75	Min.PassingMarks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-4/w

Unit	Topics	No. of Lectures
I	**Economic Globalization-** Meaning, benefits and opportunities, negative effects of globalization	8
II	**The Classical theories of international trade:** Adam Smith, David Ricardo, J.S. Mill and Haberler	8
III	Heckscher-Ohlin theorem, Leontief Paradox- Leontif's test of the Heckscher-Ohlin theorem	8
IV	**Terms of Trade:** Meaning and concepts, factors affecting terms of trade **International Trade policies:** Tariffs, quotas and subsidies; Non-tariff barriers	8
V	**Balance of Payments Accounting principles:** Debits and credits in the balance of payments, current account, capital account, official reserves, deficits and surplus in current account and capital account	10
VI	**International Financial Institutions:** IMF, World bank, WTO- TRIPS; **Economic Integration:** Custom Unions and Free Trade Areas	8
VII	**Foreign Exchange:** Meaning of foreign exchange, meaning and determination of exchange rate, exchange rate policies- fixed, flexible and mixed systems, purchasing power parity theory	10
VIII	**Key Issues in International Trade:** Import substitution versus export-pessimism, UNCTAD and world trading system, foreign direct investment vs foreign portfolio investment	8

Suggested Readings:

- Agarwal,Babita (2009) : Antarrastriya Arthshastra, Omega Publications.
- Bhatia,H.L (2006) :International Economics, Vikash Publishing House.
- Cherunilam,Francis (2008) :International Economics|| Tata McGraw Hill Education.
- Field,Alfred.J & Appleyard, Dennis.R (2013) : International Economics, McGraw Hill Education.
- Gerber,James (2012) : International Economics, Pearson.
- Jhingan, M.L (2011): Antarrastriya Arthshastra, Vrinda Publications, New Delhi.
- Krugnan,Paul.R & obstfeld, Maurice (2008) : International Economics, Pearson.
- Lal,S.N (2012) :Antarrastriya Arthshastra, Shiva Publishing House,Allahabad.
- Mannur,H.G (2001) :International Economics, Vikash Publishing House Pvt Ltd.
- Salvatore,Dominick (2012) : International Economics: Trade & Finance, Wiley Publishers.
- Sinha,V.C., Sinha,Pushpa & Sinha,Vivek (2011) : Antarrastriya Vyapar Avam Vitt, Mayur

BA 3rd Year, Semester V Course III (Project)

Program/Class: Degree/BA	Year: Third	Semester: Fifth
Subject: Economics		
Course Code: A080603R	Course Title: Elementary Statistics based Project	

Course Outcome:

- Students to be familiar with the concepts in Statistics.
- The concepts comprehended by the students shall be put to use in practice.
- The students become familiar with the practical aspects of preparing a questionnaire/interview schedule and putting them in usage.
- The information/data collected by the students should be analyzed with the help of Statistical Tools taught so as to derive inferences.
- The students shall experience the practical aspect of the theory of statistics being taught in the class room environment.
- The students are able to use statistical tools vis-à-vis given real life situation.
- Practical work to be based on the topics covered in the contents given below.

Credits:3	Core Compulsory
Max.Marks:25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-4/w

Unit	Topics	No. of Lectures
I	Introduction to Basic Concepts in Statistics: Population, Sample, Parameter, Data-Meaning & types. Questionnaire, Schedule & Interview Schedule (meaning, concept & types), Frequency Distribution, Cumulative frequency; Graphic and Diagrammatic representation of data.	45 (Class room teaching and practical)
II	Measures of Central Tendency - Mean, Median, Mode, Geometric mean and Harmonic mean. (Meaning, concept, properties & methods of measurement- in brief). Measure of Dispersion: Range, Mean Deviation, Standard deviation, Coefficient of Variation, Quartile deviation, Skewness and Kurtosis (Meaning, concept, properties & methods of measurement- in brief)	
III	Correlation: Meaning, Concept, Types & Properties. Methods of Regression: Meaning and Concept. Least squares method, Interpretation of Regression Coefficients. Meaning, concept & types of Sampling. Meaning & concept of Hypothesis & hypothesis testing.	
IV	Time Series: Concept, Meaning & Components - Determination of Regular, Trend and Seasonal Indices. Index Number: Concept, Classification of Index Numbers- price relative, quantity relative, value relative & special purpose (in brief). Consumer Price Index (CPI), Whole Sale Price Index (WPI), Methods of Construction of Index Numbers-i) Unweighted & ii) Weighted indices (in brief). Test of Adequacy of Index Number Formulae (in brief).	

Suggested Readings:

- Elhance,D.L (2010) : Sankhiki Ke Siddhant (Hindi), Kitab Mahal.
- Greenlaw, Steven A (2005): Doing Economics: A Guide to Understanding and Carrying Out Economic Research.
- Gupta,S.P (2011) : Statistical Methods, Sultan Chand & Sons, Delhi.
- Hazarika,Padmalochan (2006) : Essential Statistics for Economics and Commerce , Akansha Publishing House.
- Kothari, C.R: Research Methodology: Methods & Techniques. New Age International Publishers ISBN

Program/Class: Degree /BA	Year: Third	Semester: Sixth
Subject: Economics		
Course Code: A080601T	Course Title: Indian Economy & Economy of Uttar Pradesh	

Course Outcome:

- Students should be able familiar with the basic characteristics of Indian economy,
- Students should be able familiar with the it's potential on natural resources of Indian economy and the economy of Uttar Pradesh.
- Students are able to understand the importance, causes and impact of population growth and its distribution, translate and relate them with economic development.
- Students are able to develop an understanding about Uttar Pradesh, its demographic feature, natural resources and factors that cn stimulate its economic growth and development.
- Students should be familiar with the rural development of Uttar Pradesh over the period of time.
- Students should be familiar with the industrial development in India and in Uttar Pradesh.

Credits: 5	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w

Unit	Topics	No. of Lectures
	Part I	
I	**Structure and Features of Indian Economy:** Indian economy as a Developing Economy. Comparative Development of Indian States.	8
II	**Agricultural Sector:** Institutional Reforms, Technological change in Agriculture, Terms of Trade between Agriculture and Industry; Agricultural Policy, Policies for Sustainable Agriculture. Agrarian Crisis and Agricultural Labour.	10
III	**Industrial Sector:** Industrial Policy; Public Sector Enterprises and their Performance, Privatization and Disinvestment debate, Small, Medium and Large-scale Sector, Industrial Labour,	10
IV	**Planning in India:** Objectives and Strategy of Planning; Success story of Indian Plans; Strategy of Inclusive Growth	10
	Part II	
V	Nature, Features, Demographic Profile, Status of Natural Resources, Major Factors affecting growth and development in Uttar Pradesh.	10
VI	Sectoral growth pattern in Uttar Pradesh; Economic growth in Uttar Pradesh and Indian economy: A comparison; Infrastructural development of Uttar Pradesh.	7
VII	Pattern of land-holding and irrigation; production and productivity in agriculture, Farm mechanization, Crop diversification, agricultural credit, Agricultural policy and strategies in Uttar Pradesh, Rural Development in Uttar Pradesh.	10
VIII	Pattern of Industrial Development in Uttar Pradesh, Industrial Policy in Uttar Pradesh, Growth pattern of Services sector and Its linkages of other sectors of UP Economy. Micro, Small, Medium Enterprises (MSMEs) in Uttar Pradesh. One Product One District (OPOD).	10

Suggested Readings:

1. Agarwal,,M K (2009): Uttar Pradesh ka Arthik Vikas. New Royal Book Company
2. Annual Financial Statement (Budget) of the Government of Uttar Pradesh published in different years & the latest.
3. Annual Financial Statement (Budget) of the Government of Uttar Pradesh published in different years & the latest.
4. Annual Financial Statement (Budget)various years & Latest published by the Government of India.

Program/Class: Degree /BA	Year: Third	Semester: Sixth
Subject: Economics		
Course Code: A080602T	Course Title: Agriculture Economics	

Course Outcome

- Students should be able to comprehend and explain the approaches to economic development with respect to dualistic development.
- Students should be able to understand and explain the basics of agriculture economics.
- Students should be familiar with labour issues in agriculture sector.
- Students should be able to explain the significance of agriculture in the economic growth and economic development of an economy and in case of Indian Economy.
- Students should be familiar with the institutional initiates to strengthen the rural and agricultural development to achieve self-sufficiency.
- Students should be able to comprehend the role of credit in the development of agriculture in a country like India and the significance of institutional mechanism in this regard.

Credits: 5	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w

Unit	Topics	No. of Lectures
	Part I	
I	Models of Agricultural Development: Physiocrats approach, W. A. Lewis model, Fei & Ranis Model, Schultz Theory of Agricultural Development, Jorgenson's Dual Economy Model	10
II	Agricultural Production Function, Supply Response, Farm Size, Returns to Scale and Productivity. Cobweb Theorems. Farm Size and Productivity Debate; Theoretical and Empirical Findings. Agricultural Price Policy in India.	10
III	Labour in Agriculture- Interlocking of Factor Markets, Labour and Work Force in Rural Farm and Non-Farm Sectors. Agricultural Labour- Problem and Policy. Concept and Measurement of Rural Poverty & Employment, Poverty Alleviation Programmes	10
IV	Current Issues in Indian Agriculture: Agro- Subsidies in India, Subsidy *vs* Public Investment. Export and Imports of Agricultural Commodities, Terms of Trade in Indian Agriculture, WTO and Indian Agriculture-Bali Negotiations	10
	Part-II	
V	Role of Agriculture in Economic Growth and Development in India. Backward, Forward Linkage between Agriculture and Industry, Approaches towards Agriculture and Allocation of Resources under Different Plans in India. Employment Elasticity in Indian Agriculture, Challenges & Issues Regarding Agricultural Area Expansion,	10
VI	Land Reforms in India & Its Contemporary Relevance, Green Revolution and the Need for Second Generation, Green Revolution, Role of Infrastructural Support-Irrigation, Power, Seeds, Fertilizers,	10
VII	Role of Credit in Agricultural Development, Institutional & Non-Institutional Sources of Credit in India, Role of Schedule Commercial Banks, Lead Banks, Regional Rural Banks and NARBAD to Promote Agricultural Development.	8
VIII	Structure of Agricultural Markets in India, Issues and Challenges in the Marketing of Agricultural Products in India (With Focus on The Post Reform Period-Post 1991). Agricultural and crop Diversification Farm Incomes and Employment in Indian Agriculture.	7

BA 3rd Year, Sem. VI Course III (Optional) (Theory)

Program/Class: Degree /BA	Year: Third	Semester: Sixth
Subject: Economics		
Course Code: A080603T	Course Title: Elementary Mathematics	

Course Outcome

- Students should be familiar with the basic concepts of mathematics and their application in economics.
- Students are able to comprehend & explain the concepts of straight lines slope etc of mathematics and its application in economics.
- Students should be able to understand basics of differential & its application in economics.
- Students should be able to understand and work with matrices and determine if a given square matrix is invertible.
- Learn about and work with vector spaces and subspaces.
- Students are able to understand and work with the concepts of linear programming & graphic methods.

Credits: 5	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w

Unit	Topics	No. of Lectures
	Part I	
I	Basic Concepts: Variables, Sets, Functions, Equations, Identities, Systems of Equations	9
II	Application of Straight-Line System, Slope of the Line, Homogeneous Function.	9
III	Role of Mathematical Techniques in Economic Analysis, Theory of Numbers, Indices and Factorization.	9
IV	Progression, Growth Rate, Equilibrium.	9
	Part II	
V	Basics of Calculus: Rules of Differentiation of a Function; Maxima and Minima,	9
VI	Elasticities; Inter- relationships among Total, Marginal and Average Cost and Revenues; Constrained Optimisation Problem; Integration of a Function, Consumer's and Producer's Surplus	10
VII	Matrix and Determinants: Various types of Matrices, Determinants, Inverse of a Matrix, Crammer's Rule.	10
VIII	Concept of Linear Programming — Graphic Methods.	10

Suggested Readings:

1. Agarwal, D.R. (2009): Mathematics for Economics, Vrinda Publications, Delhi. Livernois,John., Rees,Ray., & Hoy,Michael (2012) : Mathematics for Economics , PHI Learning.
2. Agarwal, D.R. "Prarambhik Ganitiya Arthshastra (Hindi), Vrinda Publications, Delhi.
3. Allen,R.G.D (2008) : Mathematical Analysis for Economics , AITBS.
4. Bhardwaj,R.S(2006):MathematicsforEconomicsandBusiness,ExcelBooks.
5. Chiang,A.C & Wainwright,Kevin (2013) : Fundamental Methods of Mathematical Economics" McGraw Hill Publication.
6. Dowling,Edward.T(2005):Schaum'sEasyOutlineofIntroductiontoMathematical Economics , Tata Mcgraw HillEducation.
7. Madnani, G M K : Mathematics for Economics. Sultan Chand & Sons
8. Mishra,J.P. "Ganiteeya Arthshastra", Pratiyogita Sahitya.

BA3rd Year, Sem. VI Course IV (Project/Dissertation)

Program/Class: Degree/BA	Year: Third	Semester: Sixth
Subject: Economics		
Course Code: A080604R	Course Title: **Project/Dissertation**	

Course outcomes:

- The objective of introducing Dissertation/Project at the graduation level is to familiarise, aquaint and experience the local issues of economic implication or focused on economic well-being and behaviour of consumers/citizens.
- It aims at enabling the students to use and apply the learned economic principles vis-a-vis local economic issues.
- To enable them to learn preparation of questionnaire/interview schedule.
- The Template/Format of the Dissertation/Project shall be developed by the respective Department.
- The idea behind this is to develop economic thinking in the students through direct experience to real life.

Credits: 3	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:40

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

Unit	Topics	No. of Lectures
I	Dissertation Topic on the Local/Current Issues with Economic Focus plus Presentation using PPT Dissertation Report will be prepared using Statistical/Research Techniques. Surveys, Questionnaire/interview schedule. Questionnaire/Interview Schedule must be attached with the report as annexure.	45

Suggested Readings:

- Choubey, Varanya (2018): Research Writing: The Structural Challenge of Communicating Knowledge + A Method to Meet it. ISBN-13: 978-1974673162 & ISBN-10: 1974673162
- Greenlaw, Steven A (2005): Doing Economics: A Guide to Understanding and Carrying Out Economic Research, Houghton Mifflin Harcourt (HMH).
- Kothari, C R (2013): Research Methodology. New Age International Publishers.
- Paliwal, Neha & Surendra Khatri (2018): Sodh Pravidhi. National Publishing House. ISBN: 9788180181726, 8180181723
- Pandey Arun & Ganesh Pandey (2009): Sodh Pravidhi. Radha Publication. ISBN-10 : 8174873805
- Sharma, Vinay Mohan (2018): Sodh Pravidhi. Mayur Books.
- Thomson, Williams (2011): A Guide for the Young Economists. MIT Press

This course can be opted as an elective by the students of following subjects: Open for all

Suggested Continuous Evaluation Methods:
Fieldwork, Seminar, Presentations, VIVA, Dissertation.

Suggested equivalent online: Swayam

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

Programme: Certificate Class: B.A./B.Sc.	Year: First	Semester: First
Subject: Mathematics		
Course Code: B030101T	Course Title: Differential Calculus & Integral Calculus	

Course outcomes:

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 real valued functions such as sequence and series. They will also be able to know about convergence of sequence and series. Also, they have knowledge about curvature, envelope and evolutes and trace curve in polar, Cartesian as well as parametric curves.

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: 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

Part- A
Differential Calculus

Unit	Topics	No. of Lectures
I	Introduction to Indian ancient Mathematics and Mathematicians should be included under Continuous Internal Evaluation (CIE).(Appendix) Neighborhood of a point, bounded above sets, bounded below sets, Bounded Sets, Unbounded sets, open sets/intervals, closed sets/intervals, Limit points of a set, Isolated points, Limit, continuity and differentiability of function of single variable, Cauchy's definition, Uniform continuity, boundedness theorem, Intermediate value theorem, extreme value theorem, Darboux's intermediate value theorem for derivatives and Chain rule.	9
II	Rolle's theorem, Lagrange and Cauchy Mean value theorems, Taylor's theorem with various forms of remainders, Successive differentiation, Leibnitz theorem, Maclaurin's and Taylor's series. Partial differentiation, Euler's theorem on homogeneous function.	7
III	Tangent and Normal, Asymptotes, Curvature, Envelops and evolutes, Tests for concavity and convexity, Points of inflexion, Multiple points, Parametric representation of curves and tracing of parametric curves, Tracing of curves in Cartesian and Polar forms.	7
IV	Definition of a sequence, theorems on limits of sequences, bounded and monotonic sequences, Cauchy's convergence criterion, Cauchy sequence, limit superior and limit inferior of a sequence, subsequence, Series of non-negative terms, convergence and divergence, Comparison tests, Cauchy's integral test, Ratio tests, Root test, Raabe's logarithmic test, de Morgan and Bertrand's tests, alternating series, Leibnitz's theorem, absolute and conditional convergence.	7

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

Programme: Certificate **Class: B.A./B.Sc.**	**Year: First**	**Semester: First**
Subject: Mathematics		
Course Code: B030102P	**Course Title: Practical**	

Course outcomes:

CO1: The main objective of the course is to equip the student to plot the different graph and solve the different types of equations by plotting the graph using different computer software such as Mathematica /MATLAB /Maple /Scilab/Maxima etc.

CO2. After completion of this course student would be able to know the convergence of sequences through plotting, verify Bolzano-Weierstrass theorem through plotting the sequence, Cauchy's root test by plotting n^{th} roots and Ratio test by plotting the ratio of n^{th} and $(n+1)^{th}$ term.

CO3. Student would be able to plot Complex numbers and their representations, Operations like addition, subtraction, Multiplication, Division, Modulus and Graphical representation of polar form.

CO4: Student would be able to perform following task of matrix as Addition, Multiplication, Inverse, Transpose, Determinant, Rank, Eigenvectors, Eigenvalues, Characteristic equation and verification of the Cayley-Hamilton theorem, Solving the systems of linear equations.

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: 0-0-4

Unit	Topics	No. 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.

1. Plotting the graphs of the following functions:

- **i.** a^x
- **ii.** $[x]$ (Greatest integer function)
- **iii.** $x^{2n}; n \in \mathbb{N}$
- **iv.** $x^{2n-1}; n \in \mathbb{N}$
- **v.** $\frac{1}{x^{2n-1}}; n \in \mathbb{N}$
- **vi.** $\frac{1}{x^{2n}}; n \in \mathbb{N}$
- **vii.** $\sqrt{ax+b}$, $|ax+b|$, $c \pm |ax+b|$
- **viii.** $\frac{|x|}{x}, \sin\left(\frac{1}{x}\right), x\sin\left(\frac{1}{x}\right), e^x, e^{-x}$ for $x \neq 0$.
- **ix.** $e^{ax+b}, \log(ax+b), \frac{1}{ax+b}, \sin(ax+b), \cos(ax+b), |\sin(ax+b)|, |\cos(ax+b)|$.

2. Observe and discuss the effect of changes in the real constants a and b on the graphs.

- **i.** By plotting the graph find the solution of the equations $x = e^x$, $x^2 + 1 = e^x$, $1 - x^2 = e^x$, $x = \log_{10}(x)$, $\cos(x) = x$, $\sin(x) = x$, $\cos(y) = \cos(x)$, $\sin(y) = \sin(x)$ etc.
- **ii.** Plotting the graphs of polynomial of degree 2,3, 4 and 5, and their first and second derivatives.
- **iii.** Sketching parametric curves, e.g., Trochoid, Cycloid, Epicycloid and Hypocycloid etc.

B.A./B.Sc. I (SEMESTER-II) PAPER-I Matrices and Differential Equations & Geometry

Programme: Certificate **Class: B.A./B.Sc.**	**Year: First**	**Semester: Second**
Subject: Mathematics		
Course Code: B030201T	**Course Title: Matrices and Differential Equations & Geometry**	

Course outcomes:

CO1: The subjects of the course are designed in such a way that they focus on developing mathematical skills in algebra, calculus and analysis and give in depth knowledge of geometry, calculus, algebra and other theories.

CO2: The student will be able to find the rank, eigen values of matrices and study the linear homogeneous and non-homogeneous equations. The course in differential equation intends to develop problem solving skills for solving various types of differential equation and geometrical meaning of differential equation.

CO3: The subjects learn and visualize the fundamental ideas about coordinate geometry and learn to describe some of the surface by using analytical geometry.

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.

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
Matrices and Differential Equations

Unit	Topics	No. of Lectures
I	Types of Matrices, Elementary operations on Matrices, Rank of a Matrix, System of linear homogeneous and non-homogeneous equations, Theorems on consistency of a system of linear equations. Echelon form of a Matrix, Normal form of a Matrix, Inverse of a Matrix by elementary operations.	**12**
II	Eigen values, Eigen vectors and characteristic equation of a matrix, Caley-Hamilton theorem, and its applications in finding inverse of a matrix, Diagonalization of matrices.	**11**
III	Formation of differential equations, Geometrical meaning of a differential equation, Equation of first order and first degree, Equationin in which the variables are separable, Homogeneous equations, Exact differential equations and equations reducible to the exact form, Linear differential equations.	**11**
IV	First order higher degree equations solvable for x, y, p, Clairaut's equation and singular solutions, orthogonal trajectories, Linear differential equation of order greater than one with constant coefficients, Cauchy- Euler form.	**11**

B.A./B.Sc. II (SEMESTER-III) PAPER-I Algebra & Mathematical Methods

Programme: Diploma **Class: B.A./B.Sc.**	**Year: Second**	**Semester: Third**
Subject: Mathematics		
Course Code: B030301T	**Course Title: Algebra & Mathematical Methods**	

Course outcomes:

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, Ring theory and their properties.

CO2: A student learning this course gets a concept of Group, Ring, Integral Domain and their properties. This course will lead the student to basic course in advanced mathematics and Algebra.

CO3: The course gives emphasis to enhance students' knowledge of functions of two variables, Laplace Transforms, Fourier Series.

CO4: 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.

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
Algebra

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.	**11**
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 subgroups, Quotient group, Homomorphism and Isomorphism on groups, Kernel of a Homomorphism and related theorems.	**11**
IV	Rings, Elementary properties of Ring, Ring with or without zero divisors, Integral domains and field, Division ring or skew field, Homomorphism and Isomorphism on rings, Subrings, Subfields, Characteristic of a ring, Ideal and quotient rings	**11**

B.A./B.Sc. II (SEMESTER-IV) PAPER-I Differential Equations & Mechanics

Programme: Diploma **Class: B.A./B.Sc.**	**Year: Second**	**Semester: Fourth**
Subject: Mathematics		
Course Code: B030401T	**Course Title: Differential Equations & Mechanics**	

Course outcomes:

CO1: The objective of this course is to familiarize the students with various methods of solving differential equations, partial differential equations of first order and second order and to have qualitative applications.

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. These entire courses are important in engineering and industrial applications for solving boundary value problem.

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.

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.

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

Differential Equations

Unit	Topics	No. of Lectures
I	Second order linear differential equations with variable coefficients: The complete Solution in terms of A known Integral, Removal of the first order Derivative (normal form), Solution by Changing the Independent Variable, variation of parameters, Method of Operational Factors.	**10**
II	Bessel and Legendre functions and their properties, Orthogonal properties, recurrence Formula and generating Function.	**10**
III	Origin of first order partial differential equations. Partial differential equations of the first order and degree one, Lagrange's solution, Partial differential equation of first order and degree greater than one. Charpit's method of solution, Surfaces Orthogonal to the given system of surfaces.	**9**
IV	Origin of second order PDE, Solution of partial differential equations of the second and higher order with constant coefficients, Classification of linear partial differential equations of second order, Solution of second order partial differential equations with variable coefficients, Monge's method of solution.	**9**

B.A./B.Sc. III (SEMESTER-V) PAPER-I Group and Ring Theory & Linear Algebra

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Fifth**
Subject: Mathematics		
Course Code: B030501T	**Course Title: Group and Ring Theory & Linear Algebra**	

Course outcomes:

CO1: Liner 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.

CO2: Students will be able to know the concepts of group, ring and other related properties which will prepare the students to take up further applications in the relevant fields.

CO3: The student will use this knowledge in computer science, finance mathematics, industrial mathematics and bio mathematics. After completion of this course students appreciate its interdisciplinary nature.

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

Group and Ring Theory

Unit	Topics	No. of Lectures
I	Automorphism, inner automorphism, Automorphism groups, Automorphism groups of finite and infinite cyclic groups,	**10**
II	Characteristic Subgroups, Commutator subgroup and its properties; Applications of factor groups to automorphism groups, Polynomial rings over commutative rings.	**9**
III	Polynomial rings over commutative rings, Division algorithm and consequences, Principal ideal domains, Factorization of polynomials, Reducibility tests, Irreducibility tests, Eisenstein Criterion of Irreducibility of polynomials over rational field.	**9**
IV	Divisibility in integral domains, Irreducibles, Primes, Unique factorization domains, Euclidean domains.	**9**

B.A./B.Sc. III (SEMESTER-V) PAPER-II (i) Number Theory & Game Theory

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Sixth**
Subject: Mathematics		
Course Code: B030502T	**Course Title: Number Theory & Game Theory**	

Course outcomes:

CO1: Upon successful completion, students will have the knowledge and skills to solve problems in elementary number theory and also apply elementary number theory to cryptography.

CO2: This course provides an introduction to Game Theory. Game Theory is a mathematical framework which makes possible the analysis of the decision-making process of interdependent subjects. It is aimed at explaining and predicting how individuals behave in a specific strategic situation, and therefore help improve decision making.

CO3: A situation is strategic if the outcome of a decision problem depends on the choices of more than one person. Most decision problems in real life are strategic.

CO4: To illustrate the concepts, real-world examples, case studies, and classroom experiments might be used.

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

Number Theory

Unit	Topics	No. of Lectures
I	**Theory of Numbers** Divisibility; Euclidean algorithm; primes; congruences; Fermat's theorem, Euler's theorem and Wilson's theorem; Fermat's quotients and their elementary consequences; solutions of congruences; Chinese remainder theorem; Euler's phi-function.	**10**
II	**Congruences** Congruence modulo powers of prime; primitive roots and their existence; quadratic residues; Legendre symbol, Gauss' lemma about Legendre symbol; quadratic reciprocity law; proofs of various formulations; Jacobi symbol.	**9**
III	**Diophantine Equations** Solutions of ax + by = c, $x^n + y^n = z^n$; properties of Pythagorean triples; sums of two, four and five squares; assorted examples of Diophantine equations.	**9**
IV	**Generating Functions and Recurrence Relations** Generating Function Models, calculating coefficient of generating functions, Partitions, Exponential Generating Functions, A Summation Method. Recurrence Relations: Recurrence Relation Models, Divide and conquer Relations, Solution of Linear, Recurrence Relations, Solution of Inhomogeneous Recurrence Relations, Solutions with Generating Functions.	**9**

B.A./B.Sc. III (SEMESTER-V) PAPER-II (ii) Graph Theory & Discrete Mathematics

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Sixth**
Subject: Mathematics		
Course Code: B030502T	**Course Title: Graph Theory & Discrete Mathematics**	

Course outcomes:

CO1: Upon successful completion, students will have the knowledge of various types of graphs, their terminology and applications.

CO2: 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.

CO3: After successful completion, students will have the knowledge of Logic gates, Karnaugh maps and skills to proof by using truth tables. After Successful completion of this course students will be able to apply the basics of the automation theory, transition function and table.

CO4: This course covers the basic concepts of discrete mathematics used in computer science and other disciplines that involve formal reasoning. The topics include logic, counting, relations, Hasse diagram and Boolean algebra. After successful completion of this course the student will have the knowledge in Mathematical reasoning, combinatorial analysis, discrete structures and Applications.

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

Graph Theory

Unit	Topics	No. of Lectures
I	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.	**10**
II	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.	**9**
III	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**
IV	Tree, Binary and Spanning trees, Coloring, Color problems, Vertex coloring and important properties.	**9**

B.A./B.Sc. III (SEMESTER-V) PAPER-II (iii) Differential Geometry & Tensor Analysis

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Sixth**
Subject: Mathematics		
Course Code: B030502T	**Course Title: Differential Geometry & Tensor Analysis**	

Course Otcomes

CO1: After Successful completion of this course, students should be able to determine and calculate curvature of curves in different coordinate systems.

CO2: This course covers the Local theory of Curves, Local theory of surfaces, Geodesics, Geodesics curvature, Geodesic polars, Curvature of curves on surfaces, Gaussian curvature, Normal curvature etc.

CO3: After Successful completion of this course, students should have the knowledge of tensor algebra, different types of tensors, Riemannian space, Ricci tensor, Einstein space and Einstein tensor etc.

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

Differential Geometry

Unit	Topics	No. of Lectures
I	Local theory of curves-Space curves, Examples, Plane Curves, tangent and normal and binormal, Osculating Plane, normal plane and rectifying plane, osculating circle, osculating sphere Helices, Serret-Frenet apparatus, contact between curve and surfaces, tangent surfaces, involutes and evolutes of curves, Bertrand curves, Intrinsic equations, fundamental existence theorem for space curves.	**10**
II	Local Theory of Surfaces-Tangent plane, Normal, Parametric patches on surface curve of a surface, family of surfaces (one parameter), edge of regression, rues surfaces, skew ruled surfaces and developable surfaces.	**9**
III	Metric-first fundamental form and second fundamental form and arc length, Direction coefficients, families of curves, intrinsic properties.	**9**
IV	Gauss-Bonnet theorem, curvature of curves on surfaces, Gaussian curvature, normal curvature, Meusneir's theorem, mean curvature, umbilic points, lines of curvature, Rodrigue's formula, Euler's theorem.	**9**

B.A./B.Sc. III (SEMESTER-VI) PAPER-I METRIC SPACES & COMPLEX ANALYSIS

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Sixth**
Subject: Mathematics		
Course Code: B030601T	**Course Title: METRIC SPACES & COMPLEX ANALYSIS**	

Course outcomes:

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.

CO2: After completion of this course the student will have rigorous and deeper understanding of fundamental concepts in Mathematics. This will be helpful to the student in understanding pure mathematics and in research.

CO3: Students will be able to know the concepts of metric space, basic concepts and developments of complex analysis which will prepare the students to take up further applications in the relevant fields.

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

Part- A

Metric Spaces

Unit	Topics	No. of Lectures
I	**Basic Concepts-** Metric spaces**:** Definition and examples, Diameters in Metric space, Bounded and Unbounded Metric space.	**8**
II	**Topology of Metric Spaces** Open and closed ball, Neighborhood, Open set, Interior of a set, limit point of a set, derived set, closed set, closure of a set. Subspaces, Dense set.	**8**
III	**Completeness in Metric Spaces** Sequences and sub sequences in metric spaces, Convergent Sequences in metric spaces, Cluster point of a sequence, Cauchy sequences in a Metric space, Definition of Complete Metric space and examples and cantor's intersection theorem	**7**
IV	**Continuity & Uniform Continuity in Metric Spaces** Continuous mappings, Sequential criterion and other characterizations of continuity, Uniform continuity of composite functions, Homomorphism, Characterization of Homomorphism	**7**

B.A./B.Sc. III (SEMESTER-VI) PAPER-II Numerical Analysis & Operation Research

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Sixth**
Subject: Mathematics		
Course Code: B030602T	**Course Title: Numerical Analysis & Operations Research**	

Course outcomes:

CO1: The aim of this course is to teach the student the application of various numerical technique for variety of problems occurring in daily life. At the end of the course the student will be able to understand the basic concept of Numerical Analysis and to solve algebraic and differential equation.

CO2: The main outcome will be that students will be able to handle problems and finding approximated solution. Later he can opt for advance course in Numerical Analysis in higher Mathematics.

CO3: The student will be able to solve various problems based on convex sets and linear programming. After successful completion of this paper will enable the students to apply the basic concepts of transportation problems and its related problems to apply in further concepts and application of operations research.

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

PART-A

Numerical Analysis

Unit	**Topics**	**No. of Lectures**
I	**Errors in Computation-** Floating point representation of numbers, Significant Digits, Rounding and chopping, Absolute and relative errors, computation of errors using differentials, Truncation error. Solution of non-linear equations: bisection, Secant, Regular Falsi, Newton Raphson's method.	**8**
II	**Interpolation-**Some operators and their properties, Finite difference table, Error in approximating a function by polynomial, Newton forward and backward Difference formulae, Gauss forward and backward formulae, Stirling's and Bessel formulae, Lagrange's method, Divided differences and Newton's divided difference formula.	**8**
III	**Numerical differentiation** -Differentiation methods based on Newton's forward and backward formulae, Differentiation by central difference formula, Numerical Integration: Trapezoidal, Weddle, Simpsons Newton Cotes Formulas, Gaussian Quadrature Formulas.	**7**
IV	**System of Linear equations**: Direct method for solving systems of linear equations (Gauss elimination, LU Decomposition, Cholesky Decomposition), Iterative methods (Jacobi, Gauss Seidel, Relaxation methods).	**7**

B.A./B.Sc. III (SEMESTER-VI) PAPER-III Practical

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Sixth**
Subject: Mathematics		
Course Code: B030603P	**Course Title: Practical**	

Course outcomes:
The main objective of the course is to equip the student to solve the transcendental and algebraic equations, system of linear equations, ordinary differential equations, Interpolation, Numerical Integration, Method of finding Eigenvalue by Power method (up to 4 × 4), Fitting a Polynomial Function (up to third degree).

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: 0-0-4

Unit	Topics	No. of Lectures
	Practical / Lab work to be performed in Computer Lab. List of the practical to be done using computer algebra software (CAS), for example R/Python/Mathematica/MATLAB/Maple/ Maxima/Scilab etc. 1. Solution of transcendental and algebraic equations by i. Bisection method ii. Newton Raphson method (Simple root, multiple roots, complex roots). iii. Secant method iv. Regula Falsi method. 2. Solution of system of linear equations i. LU decomposition method ii. Gaussian elimination method iii. Gauss-Jacobi method iv. Gauss-Seidel method 3. Interpolation i. Lagrange Interpolation ii. Newton's forward, backward and divided difference interpolations 4. Numerical Integration i. Trapezoidal Rule ii. Simpson's one third rule iii. Weddle's Rule iv. Gauss Quadrature 5. Method of finding Eigenvalue by Power method (up to 4 × 4) i. Runge Kutta method (order 4) ii. The method of successive approximations (Picard)	

Subject prerequisite

To study Zoology in undergraduate, a student must have studied Biology, Biotechnology or Life Science in Class 12.

Programme Objectives (POs)

1. The Programm ehas been designed in such a way so that the students get the flavor of both classical and m odernaspects of Zoology/Animal Sciences. It aim sto enable the students to study animaldiversity in Indian subcontinent, environm entalscience and behavioral ecology.
2. The m odernareas includ ing cell biology and genetics, m olecular biology, biochemistry, physiology followed by biostatistics, Evolut ionary biology, bioinform atics and genetic engineering have been included to m ke the study of animals m oreinteresting and relevant to hum anstudies which is the requirem entin recent tim es
3. The lab courses have been designed in such a way that students will be trained to join p ublic or p rivate labs.

Certificate Course in Medical Diagnostics & Public Health

B.Sc. I Programme Specific Outcomes (PSOs)

PSO1	This course introduces System Biology and various functional com p onents of an organism. Em phasis will be on physiolog ical understanding abnorm alities and anom alies associated with white blood cells and red blood cells. The course em phasizes cell identification, cell differentiation and cell m orphology evaluat ion p rocedures. This will enhance hem atology analyt ical skills along with skill of using m any instrum ents
PSO 2	The students will learn the basic p rinciples of genetics and how to p rep are karyotyp es to study the chrom osom es.Young learners will fail to understand karyotyp e and their exp ressions unless they understand up streamevents changes have been m adeaccordingly.
PSO 3	How chrom osom alberrations are inherited in hum ansby p edgree analysis in families.
PSO 4	The students will have hands-on training in the techniques like microscopy, centrifugation and chromatography, and various biochemical techniques, preparation of slides which will help them in getting employment in pathology labs and contribute to health care system.
PSO 5	**The Certificate courses will enable students to apply for technical positions in government and private labs/institutes.**

Diploma in Molecular Diagnostics and Genetic Counselling	
B.Sc. II Programme Specific Outcomes (PSOs)	
PSO1	The student at the completion of the course will be able to have a detailed and conceptual understanding of molecular processes *viz.* DNA to trait. The differential regulation of genes in prokaryotes and eukaryotes leads to the development of an organism from an embryo.
PSO 2	The students will be able to understand and apply the principles and techniques of molecular biology which prepares students for further career in molecular biology. Independently execute a laboratory experiment using the standard methods and techniques.
PSO 3	The principles of genetic engineering, gene cloning, immunology and related technologies will enable students to play an important role in applications of biotechnology in various fields like agriculture, forensic sciences, industry and human health and make a career out of it. Students can have their own start-ups as well.
PSO 4	The basic tools of bioinformatics will enable students to analyze large amount of genomic data and its application to evolutionary biology. Apply knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics existing software effectively to extract information from large databases and to use this information in computer modeling.
PSO 5	**The Diploma courses will ensure employability in Hospitals/Diagnostics and Pathology labs with good hands-on training. It will also enable students to take up higher studies and Research as their career and work in renowned labs in the country and abroad.**

Degree in Bachelor of Science	
B.Sc. III Programme Specific Outcomes (PSOs)	
PSO1	• This Programme aims to introduce students to animal diversity of invertebrates and vertebrates. The students will be taught about invertebrates and vertebrates using observational strategies, museum specimens and field reports.
PSO 2	• A variety of interacting processes generate an organism's heterogeneous shapes, size, and structural features.
PSO 3	• Inclusion of ecology and environmental sciences will enrich students with our world which is crucial for human well-being and prosperity. This section will provide new knowledge of the interdependence between people and nature that is vital for food production, maintaining clean air and water, and sustaining biodiversity in a changing climate.
PSO 4	• Students will also come to know about the basic principle of life, how a cell divides leading to the growth of an organism and also reproduces to form new organisms.
PSO 5	• The basic concepts of biosystematics, evolutionary biology and biodiversity will enable students to solve the biological problems related to environment.
PSO 6	• At the end of the course the students will be capable enough to comprehend the reason behind such a huge diversity of animals and reason out why two animals are grouped together or remain separate due to similarities and differences which exist at many levels along with ecological, environmental and cellular inputs.
PSO 7	• **The Degree courses will enable students to go for higher studies like Masters and Ph.D. in Zoology and Allied subjects.**

Programme/Class: Certificate	Year: First	Semester: First
Subject: ZOOLOGY		
Course Code: B050101T	Course Title: Cytology, Genetics and Infectious Diseases	

Course outcomes:

The student at the completion of the course will be able to:

- Understand the structure and function of all the cell organelles.
- Know about the chromatin structure and its location.
- To be familiar with the basic principle of life, how a cell divides leading to the growth of an organism and also reproduces to form new organisms.
- How one cell communicates with its neighboring cells?
- Understand the basic principles of genetics and how genes (earlier called factors) are inherited from one generation to another.
- Understand the Mendel's laws and the deviations from conventional patterns of inheritance.
- Comprehend how environment plays an important role by interacting with genetic factors.
- How to detect chromosomal aberrations in humans and study the pattern of inheritance by pedigree analysis in families.

Credits: 4	Core: Compulsory
Max. Marks: 25+75	Min. Passing Marks: as p errules

Total No. of Lectures-Tutorials-Practical (in hours p erweek): L-T-P:4-0-0

Unit	Topics	Total No. of Lectures (60)
I	**Structure and Function of Cell Organelles I in Animal cell** • Plasma membrane: chemical structure—lipids and proteins • Endomembrane system: protein targeting and sorting, transport, endocytosis, exocytosis **Introduction to all national and international Biologists (Zoologists) who have contributed/contributing to Zoological and Life Sciences as a mark of tribute to ancient and modern biology will be included as part of the Continuous Internal Evaluation (CIE)** **Susruta, Charak, Patanjali, Varahamihira, Prof. H.G. Khorana, Prof. G.N. Ramachandran, Prof. Salim Ali, Prof. JP Thapliyal, Prof Lalji Singh, Prof. MK Chandrashekharan, Prof. R Mishra-to be discussed with the topics being dealt**	6
II	**Structure and Function of Cell Organelles II in Animal cell** • Cytoskeleton: microtubules, microfilaments, intermediate filaments • Mitochondria: Structure, oxidative phosphorylation; **electron transport system** • Peroxisome and ribosome: structure and function	6
III	**Nucleus and Chromatin Structure** • Structure and function of nucleus in eukaryotes • Chemical structure and base composition of DNA and RNA • DNA supercoiling, chromatin organization, structure of chromosomes • Types of DNA and RNA	8
IV	**Cell cycle, Cell Division and Cell Signaling** • Cell division: mitosis and meiosis	8

Programme/Class: Certificate	**Year**: First	**Semester**: First
Subject: ZOOLOGY		
Course Code: B050102P	**Course Title**: Cell Biology & Cytogenetics Lab	

Course outcomes:

At the completion of the course students will learn Hands-on:

1. To use simple and compound microscopes.
2. To prepare slides and stain them to see the cell organelles.
3. To be familiar with the basic principle of life, how a cell divides leading to the growth of an organism and also reproduces to form new organisms.
4. The chromosomal aberrations by preparing karyotypes.
5. How chromosomal aberrations are inherited in humans by pedigree analysis in families.
6. The antigen-antibody reaction.

Credits: 2	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

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

Unit	Topics	Total No. of Lectures (60)
I	1. Understanding of simple and compound microscopes. 2. To study different cell types such as buccal epithelial cells, neurons, striated muscle cells using Methylene blue (virtual/ slaughtered tissue). 3. To study the different stages of Mitosis in root tip of onion. 4. To study the different stages of Meiosis in testis (virtual). 5. To check the permeability of cells using salt solution of different concentrations.	15
II	1. Study of parasites (eg. Protozoans, helminths *etc.*) from permanent slides. 2. To learn the procedures for preparation of temporary (root tip of onion) and permanent stained/unstained slides, with available mounting material.	15
III	1. Study of mutant phenotypes of *Drosophila*. 2. Preparation of polytene chromosomes. 3. Preparation of human karyotype and study the chromosomal aberrations with respect to number, translocation, deletion etc. from the pictures provided. (virtual/optional). 4. To prepare family pedigrees.	15
IV	**Virtual Labs (Suggestive sites)** https://www.vlab.co.in https://zoologysan.blogspot.com www.vlab.iitb.ac.in/vlab www.onlinelabs.in www.powershow.com https://vlab.amrita.edu https://sites.dartmouth.edu	

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).

Programme/Class: Certificate	**Year**: First	**Semester**: Second
Subject: ZOOLOGY		
Course Code: B050201T	**Course Title**: Biochemistry and Physiology	

Course outcomes:

The student at the completion of the course will learn:

- To develop a deep understanding of structure of biomolecules like proteins, lipids and carbohydrates
- What simple molecules together form complex macromolecules.
- To understand the thermodynamics of enzyme catalyzed reactions.
- Mechanisms of energy production at cellular and molecular levels.
- To understand systems biology and various functional components of an organism.
- To explore the complex network of these functional components.
- To comprehend the regulatory mechanisms for maintenance of function in the body.

Credits: 4	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

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

Unit	Topics	Total No. of Lectures (60)
I	**Structure and Function of Biomolecules** • Structure and Biological importance of carbohydrates (Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates) • Lipids (saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids) • Structure, Classification and General properties of α-amino acids; Essential and non-essential α-amino acids, Levels of organization in proteins; Simple and conjugate proteins.	8
II	**Enzyme Action and Regulation** • Nomenclature and classification of enzymes; Cofactors; Specificity of enzyme action • Isozymes; Mechanism of enzyme action • Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Equation of Michaelis-Menton, Concept of Km and Vmax, Enzyme inhibition • Allosteric enzymes and their kinetics; Regulation of enzyme action	8
III	**Metabolism of Carbohydrates and Lipids** • Metabolism of Carbohydrates: glycolysis, citric acid cycle, gluconeogenesis, phosphate pentose pathway • Glycogenolysis and Glycogenesis • Lipids --- Biosynthesis of palmitic acid; Ketogenesis, • β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms	8
IV	**Metabolism of Proteins and Nucleotides**	6

Programme/Class: Certificate	**Year:** First	**Semester:** Second
Subject: ZOOLOGY		
Course Code: B050202P/R	**Course Title:** Physiological, Biochemical & Haematology Lab	

Course outcomes:
The student at the completion of the course will be able to:

- Understand the structure of biomolecules like proteins, lipids and carbohydrates
- Perform basic hematological laboratory testing,
- Distinguish normal and abnormal hematological laboratory findings to predict the diagnosis of hematological disorders and diseases.

Credits: 2	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

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

Unit	Topics	Total No. of Lectures (60)
I	1. Estimation of hemoglobin using Sahli's haemoglobinometer 2. Preparation of hemin and haemochromogen crystals 3. Counting of RBCs and WBCs using Haemocytometer 4. To study different mammalian blood cell types using Leishman stain. 5. Recording of blood pressure using a sphygmomanometer 6. Recording of blood glucose level by using glucometer	20
II	1. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid 2. Recording of simple muscle twitch with electrical stimulation (or Virtual) 3. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)	15
III	1. To prepare molecular models of nucleotides, amino acids, dipeptides using bead and stick method. 2. Ninhydrin test for α-amino acids. 3. Benedict's test for reducing sugar and iodine test for starch. 4. Test for sugar and acetone in urine. 5. Qualitative tests of functional groups in carbohydrates, proteins and lipids. 6. Action of salivary amylase under optimum conditions.	10
IV	**Virtual Labs (Suggestive sites)** 1. https://www.vlab.co.in 2. https://zoologysan.blogspot.com 3. www.vlab.iitb.ac.in/vlab 4. www.onlinelabs.in 5. www.powershow.com 6. https://vlab.amrita.edu	15

Programme/Class: Diploma	Year: Second	Semester: Third
Subject: ZOOLOGY		
Course Code: B050301T	**Course Title:** Molecular Biology, Bioinstrumentation & Biotechniques	

Course outcomes:
The student at the completion of the course will be able to have:

- A detailed and conceptual understanding of molecular processes *viz.* DNA to trait.
- A clear understanding of the processes of central dogma *viz.* transcription, translation *etc.* underlying survival and propagation of life at molecular level.
- Understanding of how genes are ultimately expressed as proteins which are responsible for the structure and function of all organisms.
- Learn how four sequences (3 letter codons) generate the transcripts of life and determine the phenotypes of organisms.
- How genes are regulated differently at different time and place in prokaryotes and eukaryotes.

Credits: 4	Core: Compulsory
Max. Marks: 25+75	Min. Passing Marks: as per rules

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

Unit	Topic	Total No. of Lectures (60)
I	**Protein synthesis I: Process of Transcription** • Fine structure of gene • RNA polymerases • Transcription factors and machinery • Formation of initiation complex • Initiation, elongation and termination of transcription in prokaryotes and eukaryotes	7
II	**Protein synthesis II: Process of Translation** • The Genetic code • Ribosome • Factors involved in translation • Aminoacylation of tRNA, tRNA-identity, aminoacyl-tRNA-synthetase • Initiation, elongation and termination of translation in prokaryotes and eukaryotes	7
III	**Regulation of Gene Expression I** • Regulation of gene expression in prokaryotes: *lac* and *trp* operons in *E. coli* • Regulation of gene expression in eukaryotes: Role of chromatin in gene expression • Regulation at transcriptional level, Post-transcriptional modifications: Capping, Splicing, Polyadenylation • RNA editing.	8

Programme/Class: Dip bma	Year: Second	Semester: Third
Subject: ZOOLOGY		
Course Code:B050302P	**Course Title:** Bioinstrum entation & Molecul ar Biobgy Lab	

Course outcomes:
The student at the completion of the course will be able to

- Understand the basic principles of microscopy, working of different types of microscopes
- Understand the basic techniques of centrifugation and chromatography for studying cells and separation of biomolecules
- Understand the principle of measuring the concentrations of macromolecules in solutions by colorimeter and spectrophotometer and use them in Biochemistry.
- Learn about some of the commonly used advance DNA testing methods.

Credits: 2	Core: Com p ulsory
Max. Marks: 25+75	Min. Passing Marks: as p errules

Total No. of Lectures-Tutorials-Practical (in hours p erw eek): **L-T-P:** 0-0-4

Unit	Topic	Total No. of Lectures (60)
I	1. To study the working principle and Simple, Compound and Binocular microscopes. 2. To study the working principle of various lab equipment such as pH Meter, Electronic balance, use of glass pippettes and micropipettes, Laminar flow, Incubator, Centrifuge, Chromatography apparatus, etc. (Any three)	15
II	1. To prepare solutions and buffers. 2. To measure absorbance in Colorimeter or Spectrphotometer. 3. Demonstration of differential centrifugation to fractionate different components in a mixture (optional).	15
III	1. To identify different amino acids in a mixture using paper chromatography. 2. Demonstration of DNA extraction from blood or tissue samples. 3. To estimate amount of DNA using spectrophotometer	15
IV	**Virtual Labs (Suggestive sites)** www.labinapp.com www.uwlax.edu www.labster.com www.onlinelabs.in www.powershow.in https://vlab.amrita.edu info@premiereducationaltechnologyies.com https://li.wsu.edu	15

Suggested Readings:

Programme/Class: Dip bma	Year: Second	Semester: Fourth
Subject: ZOOLOGY		
Course Code:B050401T	Course Title: Gene Technobgy , Im m unobgynd Com p ational Biobgy	

Course outcomes:

The student at the completion of the course will be able to:

- Understand the principles of genetic engineering, how genes can be cloned in bacteria and the various technologies involved in it.
- Know the applications of biotechnology in various fields like agriculture, industry and human health.
- To have an in depth understanding about Immune System & its mechanisms.
- Get introduced to DNA testing and utility of genetic engineering in forensic sciences.
- Get introduced to computers and use of bioinformatics tools.
- **Enable students to get employment in pathology/Hospital.**
- **Take up research in biological sciences.**

Credits: 4	Core: Com p ulsory
Max. Marks: 25+75	Min. Passing Marks: as p errules

Total No. of Lectures-Tutorials-Practical (in hours p erw eek): **L-T-P:** 4-0-0

Unit	Topic	Total No. of Lectures (60)
I	**Principles of Gene Manipulation** • Recombinant DNA Technology • Selection and identification of recombinant cells • Restriction Enzymes, DNA modifying enzymes, Cloning Vectors, Ligation • Gene transfer techniques, Gene therapy	10
II	**Applications of Genetic Engineering** • Single cell proteins • Biosensors, Biochips • Crop and livestock improvement, development of transgenics • Introduction to DNA drugs and vaccines	8
III	**DNA Diagnostics** • Genetic analysis of human diseases, detection of known and unknown mutations • Concept of pharmacogenomics and pharmacogenetics	4
IV	**Immune System and its Components** • Historical perspective of Immunology, Innate and Adaptive Immunity, clonal selection, complement system • Humoral immunity and cell mediated immunity • Structure and functions of different classes of immunoglobulins, Hypersensitivity • Suitable examples of Autoimmunity, immune deficiency, transplantation rejection	10
V	**Biostatistics I** • Calculations of mean, median, mode, variance, standard deviation • Concepts of coefficient of variation, Skewness, Kurtosis • Elementary idea of probability and application	7

At the End of the whole syllabus any remarks/ suggestions:

Programme/Class: Degree	**Year:** Second	**Semester:** Fourth
Subject: ZOOLOGY		
Course Code:B050402P/R	**Course Title:** Genetic Engineering and Counseling Lab	

Course outcomes:

The student at the completion of the course will be able to:

- Understand the principles of genetic engineering with hands-on experiments in mutation detection, testing of infectious diseases like Covid 19.
- Get introduced to DNA testing and utility of genetic engineering in forensic sciences.
- Apply knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics existing software effectively to extract information from large databases and to use this information in computer modeling.
- Use bioinformatics tools to find out evolutionary/phylogenetic relationship of organisms using gene sequences.
- Get employment in Hospitals/Diagnostic and forensic labs/Counsel families with genetic disorders.
- **Enable students to take up research in biological sciences.**

Credits: 2	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

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

Unit	Topic	Total No. of Lectures (60)
I	1. calculate mean, median, mode, standard deviation etc. with suitable biological example. 2. Measure the height and weight of all students in the class and apply statistical measures of central and variability tendencies.	10
II	1. Determination of ABO Blood group 2. To perform bacterial culture and calculate generation time of bacteria. 3. To study Restriction enzyme digestion using teaching kits. 4. To detect genetic mutations by Polymerase Chain Reaction (PCR) using teaching kits.(optional) 5. Demonstration of agarose gel electrophoresis for detection of DNA. 6. Demonstration of Polyacrylamide Gel Electrophoresis (PAGE) for detection of proteins. 7. To calculate molecular weight of unknown DNA and protein fragments from gel pictures.	20
III	1. To learn the basics of computer applications 2. To learn sequence analysis using BLAST. (NCBI) 3. To learn how to perform Primer designing for PCR using available softwares etc.	15
IV	**Virtual Labs (Suggestive sites)** 1. Gel Documentation System-https://youtu.be/WPpt3-FanNE	15

Programme/Class:Degree	Year: Third	Semester:Fifth
Subject:ZOOLOGY		
Course Code: B050501T	Course Title: Diversity of Non-Chordates and Economic Zoobgy	

Course outcomes:
The student at the completion of the course will be able to:
The student at the completion of the course will be able to:

- demonstrate comprehensive identification abilities of non-chordate diversity
- explain structural and functional diversity of non-chordate
- explain evolutionary relationship amongst non-chordate groups
- Get employment in different applied sectors
- Students can start their own business i.e. self employments.
- Enable students to take up research in Biological Science

Credits: 4	Core: Com p ulsory
Max. Marks: 25+75	Min. Passing Marks: as p errules

Total No. of Lectures-Tutorials-Practical (in hours p erw eek): **L-T-P:** 4-0-0

Unit	Topic	Total No. of Lectures (60)
I	**Protozoa to Coelenterate- Salient features and outline classification included** • Protozoa – *Paramecium* (Morphology and Reproduction) • Porifera – *Sycon*(Canal System) • Coelenterata – *Obelia* (Morphology and Reproduction)	7
II	**Ctenophora to Nemathelminthes- Salient features and outline classification included** • Ctenophora - Salient features • Platyhelminthes - *Taenia* (Tape worm) (Morphology and Reproduction) • Nemathelminthes –*Ascaris lumbricoides* (Morphology and Reproduction)	7
III	**Annelida- Salient features and outline classification included** • Annelida –*Hirudinaria* (Leech) (Morphology and Reproduction)	8
IV	**Arthropoda- Salient features and outline classification included** • Arthropoda – *Palaemon* (Prawn) (Morphology, Appendages, Nervous System and Reproduction)	8
V	**Mollusca to Hemichordata- Salient features and outline classification included**	8

At the End of the whole syllabus any remarks/ suggestions:

Programme/Class: Degree	**Year:** Third	**Semester:**Fifth
Subject:ZOOLOGY		
Course Code: B050502T	**Course Title:** Diversity of Chordates and Comparative Anatomy	

Course outcomes:
The student at the completion of the course will be able to:

- Demonstrate comprehensive identification abilities of chordate diversity
- Explain structural and functional diversity of chordates
- Explain evolutionary relationship amongst chordates
- Take up research in biological sciences.

Credits:4	**Core Compulsory/Elective**
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

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

Unit	Topic	Total No. of Lectures (60)
I	**Origin of Chordates & Hemichordata- Salient features and outline classification included** • Origin of Chordates. Classification of Phylum Chordata upto the class. • Hemichordata: General characteristics, classification and detailed study of *Balanoglossus*(Habit and Habitat, Morphology, Anatomy, Physiology and Development).	6
II	**Cephalochordata and Urochordata- Salient features and outline classification included** • Urochordata : General characteristics, classification and detailed study of *Herdmania*(Habit and Habitat, Morphology, Anatomy, Physiology and Post Embryonic Development). • Cephalochordata : General characteristics, classification and detailed study of *Branchiostoma* (*Amphioxus*) (Habit and Habitat, Morphology, Anatomy, Physiology).	6
III	**Classification and General Characteristics of Vertebrates** • General characters and Classification of different classes of vertebrates (Pisces, Amphibia, Reptilia, Aves, Mammalia) up to the order with examples. • Poisonous and Non Poisonous Snakes and biting mechanism. • Neotony and Paedogenesis • Migration in birds	8
IV	**Comparative Anatomy and Physiology of Vertebrates** **Integumentary System** Structure, functions and derivatives of integument **Skeletal System** Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches	8
	Digestive System	

Subject:ZOOLOGY	
Course Code: B050503P	**Course Title:** Lab on Virtual Dissection, Anatomy Economic Zoology and Parasitology

Course outcomes:

The student at the completion of the course will be able to:

- demonstrate comprehensive identification abilities of chordate and non- chordates diversity
- explain structural and functional diversity of chordates and non- chordates
- explain evolutionary relationship amongst chordates and non- chordates
- Generate self employment
- Enable students to take up research in biological sciences.

Credits: 2	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

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

Unit	Topic	Total No. of Lectures (60)
I	1.To prepare permanent stained slide of septal nephridia of earthworm. 2.To take out the nerve ring of earthworm. 3.To study statocyst, appendages and hastate plate from *Palaemon (demo/online allowed).*	15
II	1.Study of animal specimens of various animal phyla 2. Study on use and ethical handling of model organisms (Mice, rats, rabbit and pig). 3. To prepare stained/unstained slide of placoid scales. 1. Comparative study of bones of different vertebrates. 2. Comparative study of histological slides of different tissues of amphibia and mammals.	15
III	1. Permanent Preparation of: *Euglena, Paramecium* 2. Study of prepared slides/specimens of *Entamoeba, Giardia, Leishmania, Trypanosoma, Plasmodium, Fasciola, Taenia, Polystoma Schistosoma, Echinococcus, Enterobius, Ascaris and Ancylostoma* 3. Permanent Preparation of *Cimex* (bed bug)/ *Pediculus* (Louse), *Haematopinus* (cattle louse), fresh water annelids, arthropods; and soil arthropods as per availability. Manual microtomy has been proposed subject to consideration of members (Demo system allowable). 4. Larval stages of helminths and arthropods. 5. Permanent mount of wings, mouth parts and developmental stages of mosquito and house fly. Permanent preparation of ticks/ mites, abdominal gills of aquatic insects viz. Chironomus larva/ mayfly nymphs, preparation of antenna of housefly. 6. Identification of pests. 7. Life history of silkworm, honeybee and lac insect. 8. Different types of important edible fishes of India. 9. Study of an aquatic ecosystem, its biotic components and food chain. 10. Project Report/ model chart making.	15

Programme/Class: Degree	Year: Third	Semester: Sixth
Subject: ZOOLOGY		
Course Code: B050601T	**Course Title:** Evolutionary and Developmental Biology	

Course outcomes:

The student at the completion of the course will be able to:

- Understand that by biological evolution we mean that many of the organisms that inhabit the earth today are different from those that inhabited it in the past.
- Understand that natural selection is one of several processes that can bring about evolution, although it can also promote stability rather than change.
- Understand how the single cell formed at fertilisation forms an embryo and then a full adult organism.
- Integrate genetics, molecular biology, biochemistry, cell biology, anatomy and physiology during embryonic development.
- Understand a variety of interacting processes, which generate an organism's heterogeneous shapes, size, and structural features.
- Understand how a cell behaves in response to an autonomous determinant or an external signal, and the scientific reasoning exhibited in experimental life science.

Credits: 4	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

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

Unit	Topic	Total No. of Lectures (60)
I	**Theories of Evolution** • Origin of Life • Historical review of evolutionary concept: Lamarckism, Darwinism (Natural, Sexual and Artifical selection) • Modern synthetic theory of evolution • Adaptive radiations: Patterns of evolution (Divergence, Convergence, Parallel, Coevolution)	8
II	**Population Genetics** • Microevolution and Macroevolution: allele frequencies, genotype frequencies, Hardy-Weinberg equilibrium and conditions for its maintenance • Forces of evolution: mutation, selection, genetic drift	8
III	**Direct Evidences of Evolution** Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse	7
IV	**Species Concept and Extinction** • Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric) • Mass extinction (Causes, Names of five major extinctions	7
V	**Gamete Fertilization and Early Development** • Gametogenesis, Fertilization	6

Programme/Class: Degree	Year: Third	Semester: Six
Subject: ZOOLOGY		
Course Code:B050602T	**Course Title:** Ecology, Ethology, Environmental Science and Wildlife	

Course outcomes:

The student at the completion of the course will learn:

- Complexities and interconnectedness of various environmental levels and their functioning.
- Global environmental issues, their causes, consequences and amelioration.
- To understand and identify behaviours in a variety of taxa.
- The proximate and ultimate causes of various behaviours.
- About the molecules, cells, and systems of biological timing systems.
- Conceptualizing how species profitably inhabit in the temporal environment and space out their activities at different times of the day and seasons.
- To interpret the cause and effect of lifestyle disorders contributing to public understanding of biological timing.
- To understand the importance of wildlife conservation.

Credits: 4	Core: Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

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

Unit	Topic	Total No. of Lectures (60)
I	**Introduction to Ecology** • History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors	4
II	**Organization of Ecosystem** • Levels of organization, Laws of limiting factors, Study of physical factors, • Population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion, Exponential and logistic growth, • Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, Food web, Energy flow through the ecosystem, • Ecological pyramids and Ecological efficiencies, Nutrient and biogeochemical cycle with one example of Carbon cycle	12
III	**Community Ecology** Community characteristics: species richness, dominance, diversity, abundance, Ecological succession with one example	7
IV	**Environmental Hazards** • Sources of Environmental hazards	7

Programme/Class: Degree	**Year:** Third	**Semester:** Sixth
Subject: ZOOLOGY		
Course Code:B050603P	**Course Title:** Lab on Ecology , Environm ental Science, Behavioral Ecology & wildlife	

Course outcomes:

The student at the completion of the course will be able to:

- To understand the basic concepts, importance, status and interaction between organisms and environment.
- Get employment in forest services, sanctuaries, conservatories etc.
- Enable students to take up research in wildlife.

Credits: 2	**Core:** Com p ulsory
Max. Marks: 25+75	**Min. Passing Marks:** as p errules

Total No. of Lectures-Tutorials-Practical (in hours p erw eek): **L-T-P:** 0-0-4

Unit	Topic	Total No. of Lectures (60)
I	1.Study of life tables from the hypothetical/real data provided. 2.Study of population dynamics through numerical problems. 3.Study of circadian functions in humans (daily eating, sleep and temperature patterns).	26
II	Report on a visit to National Park/Biodiversity Park/Wildlife sanctuary	4
III	1. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses) 2. Familiarization and study of animal evidence in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers etc. 3. Demonstration of different field techniques for flora and fauna	15
IV	**Virtual Labs (Suggestive sites)** https://www.vlab.co.in https://zoologysan.blogspot.com www.vlab.iitb.ac.in/vlab	15

Suggested Readings:

1. Ecology: The Experimental Analysis of Distribution and Abundance. Charles J. Krebs, 2016, Pearson Education Inc.
2. Fundamentals of Ecology. E.P. Odum& Gray. W. Barrett, 1971, Saunders.
3. Robert Leo Smith Ecology and field biology Harper and Row publisher

CH. CHARAN SINGH UNIVERSITY, MEERUT
M.Sc.(Mathematics) SYLLABI (2010 Onwards)

			hrs/week	Max. marks
M.Sc. Semester I				
1.	**M – 101**	Algebra	6	100
2.	**M – 102**	Real Analysis	6	100
3.	**M – 103**	Differential Equations	6	100
4.	**M – 104**	Metric Spaces	6	100
5.	**M – 105**	Viva-voce based on above courses	4	100
M.Sc. Semester II				
1.	**M – 201**	Topology	6	100
2.	**M – 202**	Measure and Integration	6	100
3.	**M – 203**	Advanced Discrete Mathematics	6	100
4.	**M – 204**	Operations Research	6	100
5.	**M – 205**	Viva-voce based on above courses	4	100
M.Sc. Semester III				
1.	**M – 301**	Numerical Analysis	6	100
2.	**M – 302**	Complex Analysis	6	100
3.	**M – 303**	Mathematical Methods	6	100
4.	**M – 304**	Optional Course	6	100
5.	**M – 305**	Viva-voce based on above courses	4	100
M.Sc. Semester IV				
1.	**M – 401**	Number Theory	6	100
2.	**M – 402**	Fluid Dynamics	6	100
3	**M – 403**	Fuzzy Sets and its Applications	6	100
4.	**M – 404**	Optional Course	6	100
5.	**M – 405**	Viva-voce based on above courses	4	100

CH. CHARAN SINGH UNIVERSITY, MEERUT
SYLLABUS FOR M.Sc. (MATHEMATICS)
2010 ONWARDS

M. Sc. (MATHEMATICS) COURSE STRUCTURE & EVALUATION SCHEME

Semester	Paper Code	Title of the Paper	Lectures hrs/week		Maximum Marks		
			L	P	IA	EA	Total
I	M- 101	Algebra	6	-	50	50	100
	M- 102	Real Analysis	6	-	50	50	100
	M- 103	Differential Equations	6	-	50	50	100
	M- 104	Metric spaces	6	-	50	50	100
	M- 105	Viva-voce based on M-101 to M-104	4	-	50	50	100
II	M- 201	Topology	6	-	50	50	100
	M- 202	Measure and Integration	6	-	50	50	100
	M- 203	Advanced Discrete Mathematics	6	-	50	50	100
	M- 204	Operations Research	6	-	50	50	100
	M- 205	Viva-voce based on M-201 to M-204	4	-	50	50	100
III	M- 301	Numerical Analysis	6	-	50	50	100
	M- 302	Complex Analysis	6	-	50	50	100
	M- 303	Mathematical Methods	6	-	50	50	100
	M- 304	Elective – 1	6	-	50	50	100
	M- 305	Viva-voce based on M-301 to M-304	4	-	50	50	100
IV	M-401	Number Theory	6	-	50	50	100
	M-402	Fluid Dynamics	6	-	50	50	100
	M-403	Fuzzy Sets and its Applications	6	-	50	50	100
	M-404	Elective – 2	6	-	50	50	100
	M- 405	Viva-voce based on M-401 to M-404	4	-	50	50	100
	GRAND TOTAL						**2000**

L: Lecture; P: Practical; IA: Internal Assessment; E A: External Assessment based on End Semester Examination

CH. CHARAN SINGH UNIVERSITY, MEERUT
M.Sc.(Mathematics) SYLLABI (2010 Onwards)

M.Sc. Semester I

1. **M – 101 Algebra**
2. **M – 102 Real Analysis**
3. **M – 103 Differential Equations**
4. **M – 104 Metric Spaces**
5. **M – 105 Viva-voce based on M-101 to M-104**

M.Sc. Semester II

1. **M – 201 Topology**
2. **M – 202 Measure and Integration**
3. **M – 203 Advanced Discrete Mathematics**
4. **M – 204 Operations Research**
5. **M – 205 Viva-voce based on M-201 to M-204**

M.Sc. Semester III

1. **M – 301 Numerical Analysis**
2. **M – 302 Complex Analysis**
3. **M – 303 Mathematical Methods**
4. **M – 304 Optional Course (Any one of the following)**
   - **(I) Mechanics**
   - (II) **Algebraic Coding Theory**
   - (III) **Programming in C And Data Structure**
   - (IV) **Mathematical Statistics**
   - (V) **Partial Differential Equations**
   - (VI) **Lattice Theory**
   - (VII) **Mathematical Programming**
5. **M – 305 Viva-voce based on M-301 to M-304**

M.Sc. Semester IV

1. **M – 401 Number Theory**
2. **M – 402 Fluid Dynamics**
3 **M – 403 Fuzzy Sets and its Applications**
4. **M – 404 Optional Course(Any one of the following)**
   - **(I) Functional Analysis**
   - **(II) File Structure And Database Management System**
   - (III) **Information Theory**
   - **(IV) Mathematical Cryptography**
   - **(V) Algebraic Topology**
   - **(VI) Differential Geometry**
   - **(VII) Plasma Dynamics**
5. **M – 405 Viva-voce based on M-401 to M-404**

M – 101 ALGEBRA Teaching hrs/week: 6

The concepts and results of Algebra are fundamental to the study of Mathematics and represent a human achievement of great beauty and power and that is why the Mathematical Association of America has consistently recommended through its various Committees that a course in Algebra be a major part of any Mathematics Curriculum. Algebra is a core topic for all disciplines that use higher mathematics and logic.

After reading this course, the student shall be able to achieve the following two goals:

(i) He will learn about the core area of mathematics upon which many other areas of mathematics draw

(ii) It will help him in becoming sophisticated mathematicians.

CONTENTS

Unit-I

Normal subgroups, Quotient groups, Simple groups, Homomorphisms, Isomorphisms and Automorphisms, Cayley's theorem, Factor's theorem, Cauchy's theorem, Second Fundamental theorem.

Unit-II

Normal& Composition chains, Jordon Holder's Theorem, Solvable groups, Permutation groups, Alternating groups, Simplicity of An (n>=5), Galois theorem, Conjugacy, Class equations, Sylow's theorems, Direct products, Finite abelian groups, Fundamental theorem on finite abelian groups, Decomposable groups.

Unit-III

Rings, Ideals, Prime and maximal ideals, Homomorphism, Quotient- rings, Integral domains, Imbedding of rings, Field, Prime fields, Wilson's theorem, Zorn's lemma, Zrulls theorem, Field of quotients of an Integral domain, Euclidean domains, The ring of Gussian integers, Principal ideal domains, Unique factorization theorem, Fermat's theorem.

Unit-IV

Polynomial rings over rings and fields, Division algorithm, Gauss lemma, Eisenstein's irreduciblity criterion, Primitive polynomials, Cyclotomic polynomials, Unique factorization in R[x] where R is a Unique factorization Domain.

Unit-V

Field extensions, Algebraic and transcendental extensions, Normal extensions, Construction by Ruler and Compass, Finite fields, Structure of finite fields, Subfields of finite fields.

RECOMMENDED BOOKS:

1. **I. N. Herstein, Topics in Algebra**, New Age International (P) Limited, New Delhi
2. **P. B. Bhattacharya, S.K. Nagpaul**, **Basic Abstract Algebra** (2nd Edition) Cambridge University Press, Indian Edition, 1997.
3. **M. Artin**, **Algebra,** Prentice Hall of India, New Delhi.
5. **N. Jacobson**, **Basic Algebra Vols. I &II,** W.H. Freeman. 1980
6. **S. Lang**, **Algebra,** 3rd Edition, Pearson Education Asia, New Delhi
7. **I. S. Luther and IBS Passi**, **Algebra, Vol. I-Groups, Vol.-II Rings** Narosa Publishing House (Vol. I-1996 Vol. II-1996)
8. **J. B. Fraleigh, A First Course in Abstract Algebra**, Narosa Publishing House, New Delhi.
9. **S. K. Jain**, **A. Gunawardena and P. B. Battacharya**, **Basic Linear Algebra with MATLAB**, KCB (Springer-Verlag) 2001.

M – 102 REAL ANALYSIS

Teaching hrs/week: 6

Real Analysis is a major course in mathematics, traditionally viewed as a difficult subject. It is important that this characteristic is not as something distasteful, but provides an exciting opportunity to expand mental horizons. Indeed, Real Analysis is a very rewarding subject that allows for an appreciation of the many interconnections with other mathematical areas and makes other necessary academic commitments. Beauty and creativity involved in this important area of mathematics is highly appreciable.

The theory behind the concepts of calculus will be studied in depth and with rigor. A great deal of the course is intended to immerse the student into the world of formal/abstract mathematics in which formal proofs and definitions are used in abundance.

CONTENTS

Unit I

Definition and existence of Reimann -Stieltjes integral. Properties of the integral, Integration and differentiation, the fundamental theorem of calculus, Integration of vector-valued functions.

Unit II

Sequences and series of functions. Pointwise and uniform convergence, Cauchy criterion for uniform convergence, Uniform convergence and continuity, Uniform convergence and Riemann-Stieltjes integration, Uniform convergence and differentiation, Weierstrass approximation theorem.

Unit III

Power series, algebra of power series, Uniqueness theorem for power series. Abel's and Tauber's theorems.

Unit IV

Functions of several variables, Linear transformation, Derivatives in an open subset of R^n, Chain rule, Partial derivatives, Interchange of the order of differentiation, Derivatives of higher orders, Taylor's theorem.

Unit V

Inverse function theorem and Implicit function theorem (without proof), Jacobians, Extremum problems with constraints, Lagrange's multiplier method, Differentiation of integrals.

RECOMMENDED BOOK:

1. **Walter Rudin, Principles of Mathematical Analysis, (3rd edition)** McGraw-Hill, Kogakusha, 1976, International student edition.

REFERENCES

1. **T. M. Apostol, Mathematical Analysis,** Narosa Publishing, New Delhi, 1985.
2. **J. White, Real Analysis**, A**n Introduction**, Addison-Wesley Publishing, Co. Inc., 1968.
3. **H. L. Royden, Real Analysis, (**4th Edition**)**, Macmillan Publishing Co. Inc. New York, 1993.

M–103 DIFFERENTIAL EQUATIONS

Teaching hrs/week: 6

"The theory of differential equations" is an important branch of Mathematics. The subject may be considered to occupy a central position from which different lines of development extend in many directions. Moreover differential equations are the heart and soul of analysis. Study of differential equations is essential for understanding many physical and natural phenomena such as conduction of heat, transmission of electric waves and law of mass-action ete.
After completing the course, students will be able to formulate and solve differential equations arising from changes in physical world.

CONTENTS

Unit I

Ordinary Differential Equations: Qualitative properties of solution: Oscillation, Wronskian, Sturm separation and comparison theorems.

Unit II

Ordinary points, Regular singular points, Frobenius series solution.

Unit III

Gauss hyper geometric equation, the point at infinity, Gamma functions, Hermite polynomials

Unit IV

Partial Differential Equations: Origin of first order partial differential equations, Linear equations of the first order, Integral surfaces passing through a given curve, Surface orthogonal to a given system of surface, Non-linear partial differential equations of the first order, Charpits method, Special type of first order equations, Jacobi method. Origin of second order partial differential equation, Linear partial differential equations with constant coefficients, Equations with variable coefficients.

Unit V

Problems of Laplace, wave and diffusion equations by the method of separation of variables, Reduction of second order partial differential equation into its canonical form.
Non-linear equation of second order.

RECOMMENDED BOOKS

1- **G. F. Simmons: Differential Equations with Applications and Historical Notes,** Second Edition, Tata Mcgraw-Hill Publishing Company Ltd. New Delhi (2003).

2- **B. Rai, D.P. Chaudhary and H.I. Freedman: A Course in Ordinary Differential Equations,** Narosa Publishing House, New Delhi 2002. (Chapter 9)

3- **Ian Sneddon: Elements of Partial Differential Equation**, McGraw-Hill Book Company.

M – 104 METRIC SPACES Teaching hrs/week: 6

To gain proficiency in dealing with abstract concepts, with emphasis on clear explanations of such concepts to others, to introduce the theory of metric and topological spaces; to show how the theory and concepts grow naturally from idea of distance. To be able to give examples which show that metric spaces are more general than Euclidean spaces. To be able to work with continuous functions, and to recognize whether spaces are connected, compact or complete.
Metric spaces are vital prerequisite for most later mathematics courses including Analysis, Topology, Measure Theory, Complex Analysis etc.

CONTENTS

Unit I

Metric on a set, pseudo-metrics and metrics Distance between two sets. Equivalent metrics. Limit points and closure: closed sets, Derived set of a set. Adherent points and closure of a set, Dense-subsets, Interior of a set and its properties, Subspaces, Product spaces, Structure of Open balls in a product space. Closures and interiors in a product space, Finite product of metric spaces.

Unit II

Convergent sequences. Cauchy sequences. Characterization of adherent points and limit points in terms of convergent sequences. Convergence in products. Convergence in Euclidean spaces. Cluster points of a sequence. Subsequences. Cluster points and convergent subsequences. Algebra of convergent real sequences. Spaces of sequences.

Unit III

Continuity at a point. Continuity over a space. Continuity of composite, graph and projection maps. Algebra of real valued continuous functions in a metric space. Homeomorphisms. Isometries. Relation between isometries and Homeomorphism. Uniform continuity.

Unit IV

Complete metric spaces. Completeness and Continuous mappings. Completeness and subspaces. Cantor's Intersection Theorem. Contraction Mapping Principle. Connectedness: Connected metric spaces. Connected sets. Characterization of connected subsets of the real line. Properties of Connectedness

Unit V

Compact spaces and Compact subsets. Compact subsets of the real line. Sequential compactness and its characterization. Countable compactness, Bolzano-Weierstrass property. Sequential characterization of BWP. Equivalence of BWP and sequential compactness. Covering characterization of the BWP. Bolzano-Weierstrass Property and Total boundedness. Bolzano-Weierstrass Property and compactness. Lebesgue covering lemma. Compactness and completeness, Compactness and uniform continuity. Boundedness of continuous real-valued functions on compact metric spaces.

RECOMMENDED BOOKS:

1. **G. F Simmons:** **Introduction to Topology and Modern Analysis,** McGraw Hill, India
2. **E.T Copson:** **Metric Spaces,** Cambridge tracs
3. **Dieudonne:** **Foundation of Modern Analysis,** Academic Press, NY
4. **Kasriel:** **Metric Spaces,** Wiley, NY

M – 201 TOPOLOGY Teaching hrs/week: 6

Topology is a modern branch of geometry. It serves to lay the foundations for study in analysis and in geometry. It is also a prerequisite for functional analysis.
The course is designed to develop an understanding of topological ideas & techniques and their role in analysis.
At the end of the course, students should be able to understand and appreciate the central results of general topology, sufficient for the main applications in geometry, number theory and analysis.

CONTENTS

Unit I

Definition and examples of topological space, Closed sets, Closure, Dense subset, Neighborhoods, interior, exterior, boundary and accumulation points, Derived sets, Bases and sub-bases. Subspaces, product spaces and relative topology.

Unit II

Continuous functions, homeomorphisms, the pasting lemma, Connected and disconnected sets, connectedness on the real line, components, locally connected spaces.

Unit III

Countability axioms – First and second countable spaces, Lindelof's theorems, Separable spaces, second countability and separability.

Unit IV

Separation axioms – T_0, T_1, T_2, T_3, $T_{3½}$, T_4, their characterizations and basic properties. Urysohn's lemma and Teitze extension theorem, Statement of Urysohn's metrization theorem.

Unit V

Compactness – Continuous functions and compact sets, basic properties of compactness, compactness and finite intersection property, sequentially and countably compact sets, local compactness and one point compactification. Statements of Tychonoff's Product theorem and Stone-cech compactification theorem.

RECOMMENDED BOOKS:

1- **J. R. Munkres, Topology, A First Course,** PHI Pvt. Ltd., N. Delhi, 2000.

2- **S. Willard, General Topology**, Addison-Wesley, Reading, 1970.

3- **W. J. Pervin, Foundations of General Topology**, Academic Press Inc., New York, 1964.

4- **J. Dugundji, Topology,** Allyn and Bacon, 1966 (Reprinted in India by PHI).

5- **G. F. Simmons, Introduction to Topology and Modern Analysis**, McGraw-Hill Book Company, 1963.

6- **K D Joshi, Introduction to General Topology,** Wiley Eastern Ltd., 1983

M – 202 MEASURE AND INTEGRATION Teaching hrs/week: 6

A standard approach to integration on the real line, formalized by Riemann, is based on partitioning the domain into smaller intervals. This approach works in many situations but there are simple examples for which it fails. In 1902, H. Lebesgue produced a better theory in which the key idea is to extend the notion of length from intervals to more complicated subsets of R. This started an area of mathematics it its own right, called Measure Theory. Most generally, this is about how one may sensibly assign a size to members of a collection of sets.
To give an introduction to Lebesgue measure on the set of real numbers R and
the concept of measure in general, indicating its role in the theory of integration.
On successful completion of this course, students will understand

- how Lebesgue measure on R is constructed,
- the general concept of measure,
- how measures may be used to construct integrals,

CONTENTS

Unit I

Countable and uncountable sets, Infinite sets and the Axiom of Choice, Cardinal numbers and its arithmetic, Schroeder-Burstein theorem, Cantor's theorem and continuum hypothesis, Zorn's Lemma, Well-ordering theorem, Decimal, Binary and Ternary Expansion, Cantor's Ternary set.

Unit II

Algebra's of sets, Lebesgue outer measure, Measure of open and closed sets, Borel sets, Measurable sets, Regularity, A non-measurable sets.

Unit III

Measurable functions, Algebra of measurable functions, Step functions, Characteristic functions, Borel and Lebesgue measurability, Little wood's three principles, Convergence almost everywhere and convergence in measure, Egoroff's and Reisz- Fisher Theorems.

Unit IV

The Lebesgue Integral, Riemann and Lebesgue integral, The Lebesgue integral of a bounded function over a set of finite measure, the integral of non-negative functions, The general Lebesgue integral.

Unit V

Functions of Bounded Variation, Lebesgue Differentiation Theorem, Differentiation of Monotone Functions, Differentiation of an Integral, Absolute Continuity.

The L_p-Space, Convex function, Jensen's Holder's and Minkowsky's inequality, Completeness of L_p-space.

RECOMMENDED BOOKS:

1. **H.L. Royden**: Real analysis 4th Edition MacMillan Publishing Co. Inc. N.Y.
2. **S. Goldberg**: Real analysis Oxford and IBH New Delhi.
3. **P.K. Jain & V.P. Gupta**: Lebesgue Measure and Integration, New Age International (P) Ltd., New Delhi.
4. **G de Barra**: Measure Theory and Integration, New Age International (P) Ltd., New Delhi.
5. **Inder K. Rana**, An Introduction to Measure and Integration, Narosa Publishing House, Delhi, 1997.
6. **Walter Rudin**, Real & Complex Analysis, Tata McGraw – Hill Publishing Co. Ltd., New Delhi, 1966.

M – 203 ADVANCED DISCRETE MATHEMATICS

Teaching hrs/week: 6

The primary goal of this course is to provide an introduction to discrete structures for information technology. Discrete structure is the study of the logical and algebraic relationships between discrete objects.

At the end of the course, students will be able to relate computing theory with applications, understand and design finite state machine, understand the importance of graph algorithms, apply the concepts of Boolean algebra in various areas of computer science.

CONTENTS

Unit 1

Formal Logic- Statements, Symbolic Representation of statements, duality, Tautologies and contradictions. Quantifiers, Predicates and Validity of arguments. Propositional Logic. Languages and Grammars, Finite State Machines and their transition table diagrams.

Unit 2

Lattices: Lattices as partially ordered sets, their properties, duality, Lattices as algebraic systems, Sub lattices, Direct products, Bounded Lattices, Complete Lattices, Complemented Lattices and Distributive lattices. Cover of an elements, atoms, join and meet irreducible elements.

Unit 3

Boolean Algebras: Boolean Algebras as lattices. Various Boolean Identities. The Switching Algebra example. Sub algebras, Direct products and Homeomorphisms.

Boolean forms and their Equivalence. Min-term Boolean forms, Sum of product Canonical forms. Minimization of Boolean functions, Applications of Boolean Algebra to Switching Theory (using AND, OR & NOT gates). The Karnaugh Map method.

Unit 4

Definition of (undirected) graph, Walk, Path, Circuit, Cycles, Degree of a vertex, Connected graphs, Complete and Bipartite graphs, Planar graphs, Euler's formula for connected Planar graphs, Kuratowski's Theorem (Statement only) and its uses. Colouring of graphs, Five colour theorem and statement of Four colour theorem.

Unit 5

Trees , Cut-sets, Spanning Trees, Fundamentals Cut-sets and minimum Spanning Trees, Prim's and Kruskal's algorithms, Connectivity, Matrix Representation of graphs, Directed Graphs, Indegree and outdegree of a vertex.

RECOMMENDED BOOKS:

1. **J. P. Trembley & R. Manohar**, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co., 1997.
2. **J. L. Gersting**, Mathematical Structure for Computer Science (3rd ed.)**,** Computer Science Press, N.Y.
3. **Seymour Lepschutz**, Finite Mathematics, McGraw-Hill Book Co. New –York.
4. **J. E. Hopcroft and J.D. Ullman**, Introduction to Automata Theory Languages & Computation**,** Narosa Publishing House, Delhi.
5. **C. L. Liu**, elements of Discrete Mathematics, McGraw-Hill Book Co.
6. **N. Deo**, Graph Theory with Applications to Engineering and Computer Sciences, PHI, New Delhi

M 204 OPERATIONS RESEARCH

Teaching hrs/week: 6

Problems in optimization are the most common applications of mathematics. The main aim of this course is to present different methods of solving optimization problems in the areas of linear programming, inventory and queuing theory, In addition to theoretical treatments, there will be some introduction to numerical methods for optimization problems**.**

CONTENTS

Unit I

Operations research and its scope, Necessity of operations research in industry. Linear programming problems. Convex sets, Simplex method, Theory of simplex method. Duality theory and sensitivity analysis. Dual simplex method.

Unit II

Transportation and Assignment problems of linear programming. Sequencing theory and Travelling salesperson's problem.

Unit III

Replacement: Replacement of items that deteriorate. Problems of choosing between two machines, Replacement of items that fail completely, Problems in mortality and staffing. Inventory problems, Simple deterministic and stochastic models of inventory control.

Unit IV

Network analysis: Shortest-path problem, Minimum spanning tree problem, Maximum flow problem, Minimum cost flow problem, Network simplex method. Project planning and control with PERT/CPM.

Unit V

Queuing theory: Steady state solution of Markovian queuing models: M/M/1, M/M/1 with limited waiting space. Game theory: Two person zero-sum games, Games with mixed strategies, Graphical solutions, Solutions by linear programming.

RECOMMENDED BOOK

H.A. Taha: Operation Research- An introduction, Macmillan Publishing Co. Inc., NY

REFERENCES

1- **Kanti Swarup**, PK Gupta and Man Mohan, Operations Research, S Chand and sons, New Delhi.
2- **S.S. Rao**, Optimization Theory and Applications, Wiley Eastern Ltd, New Delhi.
3- G**. Hadley**, Linear Programming, Narosa Publishing House, 1995.
4- **F.S. Hillier** a**nd G.J. Lieberman,** Introduction to Operations Research (Sixth Edition), McGraw Hill International Edition, Industrial Engineering Series, 1995.

M 301: NUMERICAL ANALYSIS

Teaching hrs/week: 6

This course aims to provide students with the techniques for finding approximate numerical solutions to mathematical problems for which exact or analytical solutions are unavailable or inappropriate.

Successful students will have an appreciation of the difficulties involved in finding reliable solutions and will gain practical knowledge of how to apply the techniques and methods to specific problems such as finding roots of equations, quadrature and numerical solution of ordinary differential equations.

CONTENTS

Unit I

Errors in computation- Floating point representation of numbers, Significant digits, Rounding and chopping a number and error due to these absolute and relative errors, Computation of errors using differentials, Errors in evaluation of some standard functions, Truncation error. Linear equations-Gauss elimination method, LU Decomposition method, Gauss–Jordan method, Tridiagonal system, Inversion of matrix, Gauss-Jacobi method, Gauss-Seidal method.

Unit II

Nonlinear equations-Iterative method, Bisection method, Method of false position, its convergence, Secant method, Newton-Raphson method, Convergence of Newton-Raphson method for simple and multiple roots,

Unit III

Interpolation-Some operators and their properties, Finite difference table, Error in approximating a function by polynomial, Newton forward and backward Difference formulae, Gauss forward and backward formulae, Stirling's and Bessel formulae, Lagrange's method, Divided differences and Newton's divided difference formula.

Unit IV

Numerical differentiation and integration-Differentiation methods based on Newton's forward and backward formulae, Differentiation by central difference formula, Integration-Methodology of numerical integration, Rectangular rule, Trapezoidal rule,Simpson's1/3rd and 3/8th rules, Gauss-Legendre quadrature formula.

Unit V

Ordinary differential equations- Initial and boundary value problems, Solutions of Initial Value Problems, Picard's method, Taylor's method, Single and multistep methods, Euler's and Modified Euler's method, Runge-Kutta second order method and statement of fourth order, Milne's method, Adams-Bashforth method.

RECOMMENDED BOOKS

1. **Radhey S. Gupta**, Elements of Numerical Analysis, Macmillan India Ltd. New Delhi (2009).
2. **M.K. Jain, S.R.K. Iyengar, R.K. Jain,** Numerical Methods for Scientific and Engineering Computations, New Age International (P) Ltd. New Delhi (2003).
3. **James B. Scarborough**, Numerical Mathematical Analysis, , Oxford- IBH, India

M – 302 COMPLEX ANALYSIS Teaching hrs/week: 6

This course aims to provide an understanding of the basic facts of complex analysis, in particular the nice properties enjoyed by the derivatives and integrals of functions of a complex variable, and to show how complex analysis can be used to evaluate real integrals.

CONTENTS

Unit I

Complex integration. Cauchy-Goursat Theorem. Cauchy's integral formula. Higher order derivatives. Morera's Theorem. Cauchy's inequality and Liouville's theorem The fundamental theorem of algebra. Taylor's theorem. Maximum modulus principle. Schwarz lemma.

Unit II

Bilinear transformations, their properties and classifications. Definitions and examples of conformal mappings Meromorphic functions. The argument principle. Rouche's theorem. Inverse function theorem.(Statement only).

Unit III

Laurent's series. Isolated singularities. Residues. Cauchy's residue theorem. Evaluation of integrals. Branches of many valued functionswith special reference to arg z, log z and z^a .

Unit IV

Weierstrass' factorization theorem. Gamma function and its properties. Riemann zeta function. Riemann's functional equation. Runge's theorem. Mittag-Leffler's theorem. Analytic continuation. Uniqueness of direct analytic continuation. Uniqueness of analytic continuation along a curve. Power series method of analytic continuation.

Unit V

Canonical products. Jensen's formula. Poisson-Jensen formula. Hadamard's three circles theorem. Order of an entire function. Exponent of Convergence. Borel's theorem. Hadamard's factorization theorem.

RECOMMENDED BOOKS:

1. **J. B. Conway,** Functions of One Complex Variable, Springer-Verlag, International student Edition, Narosa Publishing House, 1980.
2. **L.V. Ahlfors,** Complex Analysis, McGraw-Hill,1979
3. **H. A. Priestly,** Introduction to Complex Analysis**,** Clarendon Press, 1990
4. **R.V. Churchill,** Complex Variable and Applications, McGraw Hill

M – 303 MATHEMATICAL METHODS Teaching hrs/week: 6

The course covers two important areas. The objectives of the course are to teach students new techniques namely Fourier series methods and Integral equations methods for solving ordinary and partial differential equations involving initial and boundary value conditions.
After completing the course the students will be able to understand the terminology, scope, main results, and applications of Fourier analysis and integral equations to solve problems in mathematics, science, and engineering.

Unit I

Inner products of functions. Orthogonal set of functions. Fourier series and their properties. Bessels inequality and a property of fourier constants. Parseval's equation, Convergence of Fourier series, Fourier theorem, Uniform convergence of Fourier series.

Unit II

Differentiation of Fourier series, Integration of Fourier series, Solutions of ordinary boundary value problems in Fourier series. A slab with faces at prescribed temperature. A Dirichlet problem (in Cartesian coordinates only), a string with prescribed initial velocity, an elastic bar. Applications of Fourier series in Sturm Lioville problems

Unit III

Definitions of integral equations and their classification, Relation between integral and differential equations, Fredholm integral equations of second kind with separable kernels, Reduction to a system of algebraic equations.

Unit IV

Eigen values and eigen functions, iterated kernels, iterative scheme for solving Fredholm integral equation of second kind (Neumann series), Resolvent kernel, Application of iterative scheme to Volterra's integral equation of second kind.

Unit V

Hilbert Schmidt theory, symmetric kernels, Orthonormal systems of functions. Fundamental properties of eigenvalues and eigen functions for symmetric kernels. Solution of integral equations by using Hilbert Schmidt theory.

RECOMMENDED BOOKS

1. **J. W. Brown, R.V. Churchill, Fourier Series and Boundary Value Problems,** McGraw Hill Education**,** New Delhi
2. **R. P. Kanwal, Linear Integral Equation, Theory and Technique**, Academic Press New York 1971.
3. **V. Lovitt, Linear Integral Equation,** Wiley Inter science New York**.**
4. **F. B. Hildebrand, Method of Applied Mathematics,** CHAPTER 2 (2.1-2.11,2.19) Chapter 3 (3.1,3.2,3.6,3.11**),** PHI, India

M - 304 OPTIONAL PAPER (ANY ONE OF THE FOLLOWING)

(i) Mechanics

(ii) Algebraic Coding Theory

(iii) Programming in C and Data Structure

(iv) Mathematical Statistics

(v) Partial Differential Equations

(vi) Lattice Theory

(vii) Mathematical Programming

M – 304(i) MECHANICS

Teaching hrs/week: 6

Mechanics is the oldest branch of the Physics disciplines and is as well important in the discipline of Mathematics. It is, in fact a course in Classical Mechanics.

The objective of the course is to

- develop the ability to determine the Lagrangian and Hamiltonian of mechanical systems and use these functions to obtain the corresponding equations of motions as well as identify any conserved quantities associated with the system,
- apply fundamental conservation principles to analyze mechanical systems,
- introduce advanced theoretical techniques including variational principles and Hamilton Jacobi theory and develop the capability to apply these techniques to analyze elementary mechanical systems.

CONTENTS

Unit I

Generalized coordinates, Holonomic and non-holonomic systems. Scleronomic and rheonomic systems, Constraints, Generalized potential, Lagrange's equations of motion of second kind, Energy equation for conservative field.Derivation of Lagrange's equations from D' Alembert's principle, Simple applications of the Lagrangian formulation.

Unit II

Hamilton's variables, Hamiltonian, Hamilton canonical equations, Derivation of Hamilton's equations of motion by variational principle, Simple applications of Hamilton's equations of motion, Cyclic coordinates and conservation theorems, Routh's equations of motion., The principle of least action. Derivation of Lagrange's equations from Hamilton's principle, Derivation of Hamilton's principle from D' Alembert's principle.

Unit III

Fundamental lemma of calculus of variations, Some techniques of calculus of variations, Euler's equation for functions of one dependent variable and its generalization to (i) "n" dependent variables (ii) higher order derivatives, Motivating problems of calculus of variation - Shortest distance, Minimum surface of revolution, Brachistochrone problem, Isoperimetric problem, Geodesic, Conditional extremum under geometric constraints and under integral constraints.

Unit IV

Canonical transformation, Poisson brackets, Equations of motion in Poisson brackets form, Poisson's theorem, Jacobi-Poisson theorem, Lagrange's brackets. Invariance of Poisson and Lagrange's brackets with respect to canonical transformations, Relation between Poisson and Lagrange's brackets.

Unit V

Hamilton Jacobi theory: Hamilton Jacobi equation, Jacobi theorem. Method of separation of variables in Hamilton Jacobi equation and its simple applications.

RECOMMENDED BOOK

1. **H. Goldstein,** Classical Mechanics **(**2ND Edition**),** Narosa Publishing House, New-Delhi, 2001.

REFFERENCE BOOKS

1. **A. S. Ramsey,** Dynamics Part-II, The English Language Book Society and Cambridge University Press, 1972.
2. **F. Gantmacher,** Lectures in Analytic Mechanics**,** MIR Publishers Moscow, 1975
3. **I. M. Gelfand and S.V. Fomin,** Calculus of Variations**,** Prentice Hall.
4. **Narayan Chandra Rana & Pramod Sharad Chandra Joag,** Classical Mechanics**,** Tata McGraw Hill, 1991**.**

M – 304 (ii) ALGEBRAIC CODING THEORY Teaching hrs/week: 6

The objectives of the course are to teach the students how to produce algebraic codes based on the methods of groups and finite fields and to make the students familiar with some of the most widely used codes and their applications.
Learning outcomes**:** Students will be able to understand and implement the most widely used algebraic codes. Write programs coding and decoding messages.

CONTENTS

Unit I

The Communication Channel**.** The coding problem. Types of codes. Error – Detecting and Error – Correcting Codes. Linear Codes. The Hemming Metric. Description of Linear Block Codes by Matrices.

Unit II

Dual Codes. Standard Array Syndrome. Step by Step Decoding Modular Representation. Error – Correction Capabilities of linear codes. Bounds of Minimum Distance for Block Codes. Plotkin Bound. Hamming sphere packing Bound. Bounds for Burst – Error Detecting and Correcting Codes.

Unit III

Important linear Block – Codes. Hamming Codes. Golay Codes. Perfect Codes. Quasi – perfect Codes. Reed – Muller Codes. Codes derived by Hadamard Matrices. Product Codes. Concatenated Codes.

Unit IV

A double-error correcting decimal Code and an introduction to BCH Codes, BCH bounds. Cyclic Codes. Matrix representation of Cyclic Codes.

Unit V

Hamming and Golay Codes as Cyclic Codes. Error detection with Cyclic codes. MDS Codes

RECOMMENDED BOOKS

1. **J H Van Lint**, Introduction To Coding Theory**,** Springer Verlag, Heidelberg
2. **V. Pless,** Introduction to the theory of Error – Correcting Codes**,** 3rd Edition, 1998, Wiley Interscience, New York
3. **V. Pless and W C Huffman,** Fundamentals of Error – Correcting Codes, 2003, Cambridge University Press.
4. **Raymond Hill,** A first course in Coding Theory, Oxford University Press,1986.
5. **Man Young Rhee,** Error Correcting Coding Theory, McGraw Hill Inc., 1989

M- 304(iii) PROGRAMMING IN C & DATA STRUCTURES

Teaching hrs/week: 6

This course aims to provide a conceptual understanding of computer system and languages. The objective is to equipped students with the knowledge and skills required to implement solutions to problems using the C programming language.

On completion of this course, thestudent should be able to:

1. Describe the syntax and semantics of the ANSI C programming language
2. Explain the use of functions and function decomposition;
3. Differentiate local variables from global variables, and state the scope of a variable;
4. Work in a team to analyse problems and develop C programs for solving these.

CONTENTS

Unit I

Computer system introduction, Characteristics and classification of computers, CPU, ALU, Control unit, data & instruction flow, primary, secondary and cache memories, RAM, ROM, PROM, EPROM, Programming language classifications.

Unit II

C-Programming : Representation of integers, real, characters, constants, variables, Operators: Precedence & associative, Arithmetic, Relation and Logical operators Bitwise operators, increment and decrement operators, comma operator, Arithmetic & Logical expression.

Unit III

Assignment statement, Looping, Nested loops, Break and continue statements, Switch statement, goto statement.
Arrays, String processing, functions, Recursion, Structures & unions.

Unit IV

Simple Data Structures: Stacks, queues, single and double linked lists, circular lists, trees, binary search tree. C-implementation of stacks, queues and linked lists.

Unit V

Algorithms for searching, sorting and merging e.g, sequential search, binary search, insertion sort, bubble sort, selection sort, merge sort, quick sort, heap sort.

RECOMMENDED BOOKS

1. **Kernighan & Ritchie,** The C- programming Language
2. **Balaguruswami,** Programming in C, TMH India
3. **Y.P. Kanetkar,** Let us C, BPB, India

M- 304(iv) MATHEMATICAL STATISTICS Teaching hrs/week: 6

The aim of this course is to extend and master students' knowledge of probability and statistical methods and to provide theoretical background for studying advanced statistical methods.
Upon successful completion of this course, students will be able to study, correctly apply and interpret different statistical methods.

CONTENTS

Unit I

Probability: Set theoretic approach, Baye's theorem, Geometric probability, Random experiments, Sample spaces, Random variables, Distribution functions, Joint probability distribution function, Conditional distribution function, Transformation of one and two dimensional Random variables, Mathematical expectation : Covariance, Variance of variables, Chebysheff's inequality.

Unit II

Moment generating function, Cumulant generating function and cumulants, Applications and why they are used, Discrete distributions:
Geometric, Binomial, Poisson and uniform distributions, Continuous distributions : Normal, Exponential, Gamma, Chi-square ,t , F, Beta , and uniform on an interval.

Unit III

Central limit theorem and applications (1) for a sequence of independent, identically distributed random variables (2) to establish normal approximations to other distributions, and to calculate probabilities, Statistical inference and sampling distribution.

Unit IV

Correlation and regression: Partial and multiple correlations, Correlation coefficients, rank correlation, Regression lines and its properties.

Unit V

Test of significance: (1) Null and alternative hypotheses, Simple and composite hypotheses, Errors, Test statistic. (2) Large sample tests for proportion and mean, Small sample test based on t, F and Chi-square statistics..

RECOMMENDED BOOKS

1. **V.K. Rohatgi, A. K. Md. Ehsanes Saleh**: An Introduction to Probability and Statistics, Wiley-Interscience
2. **Kennedy and Gentle**: Statistics Computing, Published by CRC Press, 1980
3. **P.L. Mayer**: Introductory Probability and Statistical Applications, IBH.
4. **A.M. Mood and F. Graybill**: Introduction to the Theory of Statistics, TMH, New Delhi.
5. **Robert V. Hogg, Allen Craig, Joseph W. McKean**: Introduction to Mathematical Statistics, Pearson Education, New Delhi

M-304(v) PARTIAL DIFFERENTIAL EQUATIONS

Teaching hrs/week: 6

Partial differential equations (PDEs) arise in every field of science and engineering. So the solutions of these PDEs are of great interest in understanding various physical phenomena. Text of this paper is organized to study the four important fundamental linear partial differential equations: Transport equation, Laplace equation, Heat equation and Wave equation, and various explicit formulas for solutions along with their numerical solutions using finite difference method. Nonlinear first order PDEs which arise in fluid dynamics, continuum mechanics and optics are also included in this paper.

CONTENTS

Unit I

Examples of PDE. Classification,
Transport Equation: Initial value Problem, Non-homogeneous Equation.
Laplace's Equation: Fundamental Solution, Mean Value Formulas, Properties of Harmonic Functions, Energy Methods.

Unit II

Heat Equation: Fundamental Solution; Mean Value Formula, Properties of Solutions, Energy Methods.
Wave Equation: Solution by Spherical Means. Non-homogeneous Equations, Energy Methods.

Unit III

Nonlinear First Order PDE-Complete Integrals, Envelopes, Characteristics; Hamilton -Jacobi Equations (Calculus of Variations, Hamilton's ODE, Legendre Transform, Hopf-Lax Formula, Weak Solutions, Uniqueness), Conservation Laws (Rankine-Hugoniot condition, Lax-Oleinik formula, Weak Solutions, Uniqueness).

Unit IV

Representation of Solutions-Separation of Variables, Similarity Solutions (Plane and Traveling Waves, Solitons, Similarity Linder Scaling), Fourier and Laplace Transform, Hopf-Cole Transform, Hodograph and Legendre Transforms. Potential Functions.

Unit V

Deriving Difference Equations, Elliptic Equations: Solution of Laplace's equation, Leibmann,s method, relaxation method, solution of Poisson's equation, Parabolic equation : solution of heat equation, Bender-Schmidt method. The Crank-Nicholson method, Hyperbolic equations : solution of hyperbolic equation.

RECOMMENDED BOOKS

1. **L.C. Evans**, Partial Differential equations. Graduate Studies in Mathematics. Volume 19, AMS, 1998.
2. **P. Prasad and R. Ravindran**, Partial Differential equations, New Age International Pub., N. Delhi..
3. **F. John**, Partial Differential equations, Springer- Verlag, N. York

M - 304(vi) LATTICE THEORY Teaching hrs/week: 6

Lattice theory is one of the important branches of algebra. Its concepts and methods have found fundamental applications in various areas of mathematics (e.g. diverse disciplines of abstract algebra, mathematical logic, projective and affine geometry, set and measure theory, topology) and theoretical physics (e.g. quantum and wave mechanics, and the theory of relativity)
At the end of the course, students will be able to understand the connections of lattice theory with other branches of mathematics.

CONTENTS

Unit I

Lattices: Algebra of lattices, the lattice theoretic duality principal, lattices as partly ordered sets, diagrams of lattices, sub-lattices, ideals, atoms, complements, relative complements, semi complements, irreducible and prime elements of a lattice and homeomorphisms of a lattice.

Unit II

Complete Lattices: Complete lattices, complete sub-lattices of complete lattice, conditionally complete lattice, and subalgebra, lattices of an algebra, closure operations, Galois connection, Dedekind cuts, and partly ordered sets as topological spaces.

Unit III

Modular lattices: Modular lattices, characterization of modular lattices by their sublattices, the isomorphism theorem of modular lattices, the covering condition, meet representations in modular lattice.

Unit IV

Distributive Lattices: Distributive lattices, infinite distributive and completely distributive lattices, Boolean algebra, characterization of distributive lattices by their sublattices, distributive sublattices of modular lattices, meet representations in distributive lattice.

Unit V

Special Subspaces of the Class of Modular Lattices: Modular lattices of locally finite length, the valuation of a lattice, metric and quest metric lattices, complemented modular Lattices.

RECOMMENDED BOOKS

(1) Introduction to Lattice Theory by G. Szasz. Ch. IV- X, Academic Press, NY
(2) Lattice Theory by G. Birkhoff
(3) Introduction to Lattices theory by D. E. Rutherford

M-304(vii) MATHEMATICAL PROGRAMMING Teaching hrs/week: 6

This course presents the theory and application of Mathematical Programming. Prerequisite of this course is M-204. It extents the theory of optimization methods to more realistic problems.

After completing this course students will be able to

1. Solve problems involving optimization models with integer constraints.
2. Have deep insight in solving optimization problems which are non-linear.
3. Distinguish between "single objective" and "multiple objective" functions.

CONTENTS

Unit I

Convex sets, convex functions, pseudo-convex functions, quasi-convex, explicit quasi-convex, quasi-monotonic functions and their properties from the point of view of mathematical programming. Kuhn-Tucker conditions of optimality.

Unit II

Theory of revised simplex algorithm. Duality theory of linear programming. Sensitivity analysis.

Unit III

Parametric linear programming. Integer programming and linear goal programming.

Unit IV

Quadratic programming: (i) Wolfe's algorithm (ii) Beale's algorithm (iii) Theil and Vande-Panne algorithm.

Unit V

Duality theory of quadratic and convex programming, separable programming, sequential unconstrained minimization.

RECOMMENDED BOOKS

1. **G. Hardy,** Linear Programming, Narosa Publishing house, 1995
2. **G. Hardy**, Nonlinear and Dynamic Programming, Addison-Wesley, Reading Mass.
3. **H. A.Taha**, Operations Research- An introduction, Macmillan Publishing Co, New York.
4. **N. S. Kambo**, Mathematical Programming Techniques, Affiliated East-West Press.
5. **O. L. Mangasarian**, Non linear Programming, McGraw Hill, New York.

M – 401 NUMBER THEORY Teaching hrs/week: 6

The aim of the course is to give an introduction to elementary number theory, to show how certain number theoretical theorems can be applied within cryptography and to use the theory to solve simple Diophantine equations.

CONTENTS

Unit I

The Division Algorithm, the gcd, The Euclidean Algorithm, Diophantine equation ax + by = c. The fundamental theorem of arithmetic. The Sieve of Eratosthenes. The Goldbach conjecture.

Unit II

Theory of Congruences – Basic properties of Consequence, Linear Congruences, Chinese remainder theorem, Fermat's Theorem, Wilson's Theorem. Statement of Prime number theorem. Some primality testing.

Unit III

Number-Theoretic Functions – The functions T and Sigma. The mobius inversion formula, The Greatest integer function, Euler's Phi function – Euler Theorem, Properties of the Phi-function, Applications to Cryptography.

Unit IV

The order of an integer modulo n, Primitive roots for primes, The theory of indices, Euler's criterion, Legendre's symbol and its properties, Quadratic reciprocity, Quadratic congruences with composite moduli.

Unit V

Perfect Numbers, Representation of integers as sum of two squares and sum of more than two squares.

RECOMMENDED BOOK:

1. **Davis M. Burton**: Elementary Number Theory, USB (Indian Reprint), 1991.

REFERENCES

1. **U. Dudley**, Elementary Number Theory, Freeman & Co.
2. **George Andrews**, Number Theory.

M – 402 FLUID DYNAMICS Teaching hrs/week: 6

Almost everything on this planet either is a fluid or moves within or near a fluid.
Fluids have the ability to transport matter and its properties as well as transmit force; therefore Fluid Mechanics is an important subject that is particularly open to cross fertilization with other sciences and disciplines of engineering.

The main objective of the course is

- to develop fundamental knowledge and understanding of the mechanics of fluid at rest and in motion,
- to ability to demonstrate ability to formulate physical problems encountered in different branches of engineering in mathematical form and arrive at useful solutions

CONTENTS

Unit I

Concept of fluid and its physical properties, Continuum hypothesis, Kinematics of fluids-Methods of describing fluid motion, Translation, Rotation and deformation of fluid elements, Stream Lines, Path lines and Streak lines, concepts of Vorticity.

Unit II

General theory of stress and rate of strain in a real fluid –Symmetry of stress tensor, Principal axes and Principle values of stress tensor, Constitutive equation for Newtonian fluid. Conservation laws-Conservation of mass, Conservation of momentum, Conservation of energy.

Unit III

One and two dimensional inviscid incompressible flow-Equation of continuity and motion using stream tube, , Circulation, Velocity potential, Irrotational flow, Some theorems about rotational and irrotational flows – Stoke's theorem, Kelvin's minimum energy theorem, Gauss theorem, Kelvin's circulation theorem.

Unit IV

Vortex motion and its elementary properties, Integration of equations of motion - Bernoulli's equation, Stream function in two dimensional motion, Complex variable technique, flow past a circular cylinder, Blasius theorem, Milne's circle theorem, Sources, Sinks and Doublets. Dynamical similarity, Buckingham's pie theorem, Non-dimensional numbers and their physical significance

Unit V

Incompressible viscous fluid flows- Steady flow between two parallel plates (non-porous and porous) - Plane couette flow, Plane poiseuille flow, Generalized plane couette flow, Steady flow of two immiscible fluids between two rigid parallel plates, Steady flow through tube of uniform circular cross section, Steady flow through annulus under constant pressure gradient.

RECOMMENDED BOOKS

1. **S. W. Yuan, FOUNDATIONS OF FLUID MECHANICS**, Chapters- 1, 3, 4, 5, 6, 7, 8. Prentice Hall of India Private Limited, New-Delhi, 1976.
2. **R. K. Rathy, AN INTRODUCTION OF FLUID DYNAMICS**, Chapters – 1, 3, 4, 5, 6, 7,8,11. Oxford and IBH Publishing company, New Delhi, 1976.

REFFERENCE BOOKS

1. **G. K. Betchelor, AN INTRODUCTION OF FLUID MECHANICS**, Oxford University Books, New Delhi, 1994.
2. **F. Charlton, TEXT BOOK OF FLUID DYNAMICS**, C.B.S. Publishers, Delhi. 1985

M – 403 FUZZY SETS AND ITS APPLICATIONS Teaching hrs/week: 6

The course presents some fundamental knowledge of fuzzy sets, fuzzy logic and its applications in fuzzy decision making. The aim is to equip students with some state-of-the-art fuzzy-logic technology to prepare them in a better way for the rapidly evolving high-tech information-based modern industry and market.

Objectives: Upon successful completion of this course, students should

1. be able to understand basic knowledge of fuzzy sets and fuzzy logic,
2. be able to apply fuzzy inferences,
3. be able to apply fuzzy information in decision making,
4. be able to appreciate the theory of possibility on the basis of evidences**.**

Unit I

Basic definitions, α -level sets, comparison with classical (crisp) sets,
Types of fuzzy sets, extension principle.

Unit II

Fuzzy complement, t-norms, t-conorms, combination of operations, aggregation operations.
Fuzzy numbers, linguistic variables, arithmetic operations on intervals, arithmetic operations on fuzzy numbers, lattice of fuzzy numbers, fuzzy equations.

Unit III

Crisp versus fuzzy relation, projections and cylindric extensions, binary fuzzy relations, binary relations on a single set, fuzzy equivalence relations, fuzzy compatibility and fuzzy ordering relations.
Fuzzy measures, evidence theory, possibility theory, fuzzy sets and possibility theory.

Unit IV

An overview of classical logic, multivalued logic, fuzzy propositions, fuzzy quantifiers, linguistic hedges, Inference from conditional fuzzy propositions, Inference from conditional and qualified propositions.
Information and uncertainty, non-specificity of crisp and fuzzy sets, fuzziness of fuzzy sets.

Unit V

Individual, multiperson, multicriteria decision making, fuzzy ranking method, fuzzy linear programming. Methods of defuzzyfication.

RECOMMENDED BOOKS:

1. Fuzzy Sets and Fuzzy Logic: Theory and Applications, **George J. Klir and Bo Yuan**, Prentice Hall of India, New Delhi.
2. Fuzzy Set Theory & its Applications, **H.J. Zimmermann**, Allied Publishers Ltd. New Delhi.
3. Fuzzy Logic with Engineering Applications, **Timothy J. Ross**, McGraw Hills inc. New Delhi

M-404 Optional Paper (Any one of the following)

(i) Functional Analysis
(ii) File structure and Database Management System
(iii) Information Theory
(iv) Mathematical Cryptography
(v) Algebraic Topology
(vi) Differential Geometry
(vii) Plasma Dynamics

M – 404 (i) FUNCTIONAL ANALYSIS Teaching hrs/week: 6

This course extends the ideas studied in Analysis and Topology. Many of the topics studied in the course have applications in Approximation theory, operator's theory and other areas of mathematics.
At the end of the course, students will be aware of interplay of algebra and topology.

CONTENTS

Unit I

Normed linear spaces, Banach spaces, Examples and counter examples, Quotient space of normed linear spaces and its completeness. Equivalent norms,

Unit II

Reisz Lemma, Basic properties of finite dimensional normed linear spaces, Bounded linear transformations and normed linear spaces of bounded linear transformations, Uniform boundedness theorem and some of its applications.

Unit III

Dual spaces, weak convergence, open mapping and closed graph theorems, Hahn Banch theorem for real and complex linear spaces.

Unit IV

Inner product spaces, Hilbert spaces – Orthonormal sects, Bessel's inequality, complete orthonormal sets and Perseval's identity.

Unit V

Structure of Hilbert spaces, Projection theorem, Riesz representation theorem, Adjoint of an operator on Hilbert space, Self adjoint operators, Normal and Unitary operators. Projections

RECOMMENDED BOOKS

1. **C.Goffan & G Pedrick:** First course in Functional Analysis, PHI, New Delhi
2. **P.K. Jain, O.P. Ahuja & Khalil Ahmad**: Functional Analysis, New Age (International P. Ltd.) New Delhi.
3. **E. Kreyszig**: Introductory Functional Analysis with Applications, John Wiley and Sons, New York.
4. **G.F. Simmons**: Introduction to Topology and Modern Analysis, McGraw Hill Book Co., New York.
5. **A.E. Taylor**, Introduction to Functional Analysis, John Wiley and Sons, New York.
6. **Bela Bollobas**: Linear Analysis, an introductory course, Cambridge University Press, Cambridge.
7. **S.K. Berbarian**: Introduction to Hilbert Spaces, Oxford University Press, New York.

M-404(ii) FILE STRUCTURE AND DATABASE MANAGEMENT SYSTEM

Teaching hrs/week: 6

The aims and objectives of this course are

- To understand the basic concepts of file organization and Database
- To discuss the advantages of database system over conventional file system
- To make a logical and analytical comparison of different Data Models
- To provide strong dimensions, strengths and future prospects of Database Systems.
- To design and implementation of Database Modeling
- To transform ERD (Entity Relationship Diagram) into relations
- To develop good skills in SQL (Structured Query Language).

After successful completion of the course, students will be able to understand the Database System environment; Design and implement a Relational database for real life problems, Expertise in writing SQL queries, Suggest, design and implement solutions for the small business organizations.

CONTENTS

Unit I

File Organization: the constitution of a file, Operations on files, Primary key Retrieval, Sequential files, index sequential files: implicit index, limit indexing multilevel, indexing schemes, Structure of index sequential file, VSAM direct files, hashing techniques, Extended hashing.
Secondary Key Retrieval: Inverted and Multilist files.
Indexing Using Tree Structures: Tree schemes, operation, capacity, B-Tree, B^+- trees.

Unit II

Data base Management System: What is DBMS? Three - level architecture of DBMS.
Relation Data Model: Relational Database**:** Attributes and domains, Tuples, Relations and their schemes, Relation representation, Keys, Relational operations, Integrity Rules **Relational Algebra**: Basic Operations, Additional Relation algebraic operations, Some Relational Algebra Queries.

Unit III

Structural Query Language (SQL): Data definition, Data manipulation, Condition Specification, Arithmetic and aggregate operators, SQL join, Set Manipulation, categorization, updates.

Unit IV

Relational Database Design: Functional dependencies. First, second third and BCNF normal Forms,. Data integrity and recovery.

Unit V

Concurrency and security Management: Security of database. Serializability. Locking Schemes. Time stamp based order.

References:

1. Ullman, J D : Principles of Database systems.
2. Date, C.J. : Introduction to database system, Addison Wesley.
3. Bipin Desai : An Introduction to database system. Galgotia Publications.
4. A. Silberschatz : Introduction to Data base Management System, Tata McGraw Hill, New Delhi

M 403(iii) INFORMATION THEORY Teaching hrs/week: 6

Information theory is concerned with the analysis of an entity called a communication system. It deals with the construction of a mathematical model for different blocks of information. It is oriented towards the fundamental limitations on the processing and communication of information. After the completion of the course, the students will be able to understand fundamentals of communication system.

CONTENTS

Unit I

Measure of Information: Axioms for a measure of uncertainty. The Shannon entropy and its properties. Join and condition entropies. Transformation and its properties.

Unit II

Noiseless Coding: Ingredients and noiseless coding problem. Uniquely decipherable codes. Necessary and sufficient condition for the existence of instantaneous codes. Construction of optimal codes.

Unit III

Discrete Memory less Channel: Classification of channels. Information processed by a channel. Calculation of Channel capacity. Decoding Schemes. The ideal observer. The Fundamental Theorem of Information Theory and its strong and weak converses.

Unit IV

Continuous Channels: The Time – discrete Guassian Channel. Uncertainty of absolutely continuous random variable. The converse to the coding theorem for time – discrete Gaussian Channel. The time – continuous Gaussian Channel. Band – limit Channels.

Unit V

Some intuitive properties, maximality, Stability, additivity, subadditivity, nonnegativity, continuity, branching etc and interconnection among them. Axiomatic characterization of the Shannon entropy due to Shannon and Fadeev.

References

1. **R. Ash** , Information Theory**,** Interscience, New York, 1995
2. **F. M. Reza,** An Introduction to Information Theory, McGraw Hill Book Company Inc. 1961
3. **J. M. Aczel and Z. Daroczy**, On Measures of Information and their Characterizations**,** Academic Press, New York.

M 404(iv) MATHEMATICAL CRYPTOGRAPHY

Teaching hrs/week: 6

Objective: To make students aware of some tools for network security and the mathematics behind their construction and strength.
After completing this course students will be able to use concepts from number theory, group theory, and ring theory to encrypt and decrypt messages using elementary ciphers such as affine ciphers, substitution ciphers, permutations ciphers, block ciphers, Playfair ciphers; encrypt and decrypt messages using public-key encryption systems such the RSA encryption system, and the ElGamal encryption system.

CONTENTS

Unit-I

Classical cryptography: Encryption schemes, Symmetric key encryption, Feistel ciphers, NDS, DES, Multiple encryptions, Modes of operation, Applications to authentication and identification.

Unit-II

Some Mathematical Tools: Algorithm, complexity, Modular arithmetic, Quadratic residues, Primality testing, Factoring and square roots, Discrete logarithm.

Unit-III

Public key Cryptography: Public key cryptosystems and their applications, RSA algorithm and its security, Key management, Diffie-Hellman key exchange.

Unit-IV

Elliptic curve cryptography, ID based public key cryptosystems.

Unit-V

Introductory concepts of Signcryption and Certificate less public key cryptosystems.

RECOMMENDED BOOKS

1. **D. R. Hankerson et al**, Coding Theory and Cryptography**.** Monographs and Textbooks # 234, Marcel Decker, 2000.
2. **W. Stallings**,Cryptography and Network Security, Prentice Hall India, 2000.

The following material from Internet

1. **Y. Zheng,** Digital signcryption or How to achieve cost (signature + encryption) < < cost (signature) + cost (encryption). Available at http://www.signcryption.org/publications/pdffiles/yz-c97-fnl-rvs.pdf
2. **D. Boneh and M. Franklin**, Identity based encryption from Weil pairing. Available at http://eprint.iacr.org/2001/090.pdf
3. **S. S. Al-Riyami and K. G. Patterson,** Certificate less public key cryptography. Available at http://eprint.iacr.org/2003/126.pdf

M – 404(v) ALGEBRAIC TOPOLOGY Teaching hrs/week: 6

The main goal of the course is to introduce students to algebraic topology and standard topological invariants. We also intend to discuss different connections with differentiable topology, (co)homology theory and complex/real algebraic geometry.
Learning outcomes: The students will learn important notions and results in algebraic topology, homological algebra and related invariants associated with topological spaces and continuous maps. They will gain crucial skills and knowledge in several parts of modern mathematics. Via the exercises, they will learn how to use these tools in solving specific topological problems.

CONTENTS

Unit I

Homotopy of paths, the Fundamental group, covering spaces, the fundamental group of the circle, Retractions and fixed points, the fundamental group of the punctured plane.

Unit II

Deformation retracts and hotopy type, the fundamental group of S^n, Essential and inessential maps, the fundamental theorem of Algebra.

Unit III

Topology of E^n, Borsuk's separation theorem, deformation of subsets of E^{n+1}, the Jordan curve theorem, fiber spaces, Hurwicz uniformization theorem.

Unit IV

Classification of Surfaces: Fundamental groups of surfaces, Homology of Surfaces, Cutting and Pasting, the Classification theorem.

Unit V

Classification of Covering Spaces: Equivalence of Covering Spaces, Universal Covering Space, Covering Tranformations.

RECOMMENDED BOOKS

1. **James R Munkres**, Topology - A Modern Introduction, Prentice Hall of India, Delhi 1978.

REFERENCE BOOKS

James Dugundji, Topology, Allyn and Bacon, New York, 1975

1. **Marwin J Greenberg and J R Harper,** Algebraic Topology – A First Course, Addison Wesley, 1981
2. **W S Massey,** Algebraic Topology- An Introduction, Harcourt Brace,1977
3. **Satya Deo,** Algebraic Topology, Hindustan publishing House (TRIM Series)
4. **E H Spanier,** Algebraic Topology, Tata McGraw-Hill Private Ltd, New Delhi.

M-404(vi) DIFFERENTIAL GEOMETRY Teaching hrs/week: 6

Differential geometry is a mathematical discipline that uses the methods of differential and integral calculus, as well as linear and multilinear algebra, to study problems in geometry. The theory of plane and space curves and of surfaces in the three-dimensional Euclidean space formed the basis for its initial development in the eighteenth and nineteenth century. Since the late nineteenth century, differential geometry has grown into a field concerned more generally with geometric structures on differentiable manifolds. It is closely related to differential topology, and to the geometric aspects of the theory of differential equations. Grigori Perelman's proof of the Poincaré conjecture using the techniques of Ricci flow demonstrated the power of the differential-geometric approach to questions in topology and highlighted the important role played by the analytic methods. Differential geometry of surfaces already captures many of the key ideas and techniques characteristic of the field.

CONTENTS

Unit I

Theory of space curves, arc length, tangent and normals, Curvature and torsion of curve given as the intersection of two surfaces, Involute and Evolute.

Unit II

Metric: The first and second fundamental form, Weingarton equation, Orthogonal trajectories, Mensuier theorem, Gaussian curvature, Euler's theorem, Dupin's theorem, Rodrigue's theorem, Dupin's indicatrix.

Unit III

Envelopes, Edge of regression, Ruled surface. Developable surface, Monge's theorem, Conjugate directions.

Unit IV

Asymptotic lines, the fundamental equations of surface theory, Gauss's formulae, Gauss characteristics equations, Mainardi Codazzi equations, Weingarton equations, Bonnet's theorem on parallel surface.

Unit V

Geodesics, Clairaut's theorem, Gauss Bonnet theorem, conformal mapping and Geodesic mappings, Tissot's theorem, Dini's theorem.

RECOMMENDED BOOKS

1. **J.A. Thorpe,** Introduction to Differential Geometry, Springer-verlag.
2. **B.O. Neill,** Elementary Differential Geometry, Academic Press, 1966.
3. **S. Ternberg,** Lectures on Differential Geometry, Prentice-Hall, 1964.
4. **M. DoCarmo.** Differential Geometry of Curves and Surfaces, Prentice Hall, 1976.
5. **D. Laugwitz**, Differential and Riemannian Geometry, Academic Press, 1965.
6. **R.S. Millman and G.D. Parker**, Elements of Differential Geometry, Prentice Hall, 1977.
7. **W. Kleingenberg,** A course in Differential Geometry, Springer-Verlag.
8. **T.J. Willmore,** An Introduction to Differential Geometry and Riemannian Geometry, Oxford University Press, 1965.

M-404(vii) PLASMA DYNAMICS Teaching hrs/week: 6

Plasma dynamics is a branch of applied mathematics. Plasma is electrified or ionized gas with atoms dissociated into positive ions and negative electrons. Plasma is generally known as fourth state of matter. It is likely that 99% of the matter in the universe is in the plasma state and we live in the 1% of the universe in which plasma do not occur naturally. Some important applications of man-made plasmas are in gaseous electronics, MHD generator and controlled thermonuclear fusion.

Background knowledge of fluid dynamics is a necessary prerequisite. There must also be familiarity with Maxwell's equations, mechanics, vector algebra, ordinary & partial differential equations, and complex variable. The approach to plasma dynamics begins with a description of the orbits of charged particles in electromagnetic field followed by a treatment of hydromantic which includes discussions of flows, shocks and wave motion.

CONTENTS

Unit I

Introduction: Definition of plasma, Criteria for plasmas, Occurrence of plasma in nature, Applications of plasma physics.

Particle orbit theory: Constant uniform magnetic field, Constant uniform electric and magnetic fields, Inhomogeneous magnetic field, Time-varying electromagnetic fields, magnetic mirrors, Earth's radiation belts.

Unit II

Elements of Plasma Kinetic Theory: Phase space, Distribution function, Number density and average velocity, Boltzmann equation, Relaxation model for the collision term, Vlasov equation.

Average values and Macroscopic variables: Average velocity and peculiar velocity, Flux, Particle current density, Momentum flow tensor, Pressure tensor, Heat flow vector and triad, total energy flux triad.

Unit III

Macroscopic Equations: Fluid model of a plasma, Moment equations, Hydro magnetic equations, Criteria for applicability of a fluid description.

Hydromantic: Kinematics, Static problems, Hydro magnetic stability, Interchange instabilities, Alfven waves.

Unit IV

Hydro magnetic Flows: Hydro magnetic Navier-Stokes equation, Hartmann flow, Couette flow, Flow stability, parallel flows, Transverse flows.

Shock Waves in Plasmas: Hydro magnetic shock equations, Shock propagation parallel to magnetic field, Shock propagation perpendicular to magnetic field.

Unit V

Waves in Cold Plasmas: Some general wave concepts, Waves in cold plasmas: Alfven waves, Ion-cyclotron waves, Experimental results for low frequency waves, General theory of waves in cold plasmas.

Waves in Warm Plasmas: MHD waves, Longitudinal waves in warm plasmas, Ion acoustic waves, Landau damping of longitudinal plasma waves, Experimental results for waves in warm plasmas, General dispersion relation.

RECOMMENDED BOOKS

1. **T. J. M .Boyd and J.J. Sanderson,** Plasma Dynamics, Nelson, 1969.
2. **J. A. Bittencourt,** Fundamentals of Plasma Physics, Springer (2004)
3. **F.F. Chen**, Introduction to Plasma Physics, Plenum Press, New York & London, 1974.
4. **Paul. M Bellan**, Fundamentals of Plasma Physics, Cambridge University Press (2006).
5. **J.L. Delcroix,** Plasma Physics, John Wiley & Sons Ltd, 1965.
6. **Arnab Rai Choudhury**, The Physics of Fluids & Plasmas, Cambridge University Press, 1999.
7. **N.A. Krall and A.W. Trivelpiece,** Principles of Plasma Physics, McGraw-Hill, 1973.
8. **Vinod Krishan,** Astrophysical Plasmas and Fluids, Kluwer Academic Publishers, Dordrecht.

F	Chronobiology	9	B050913T	Chronobiology	Theory	4
			B050914T	Photoperiodism and Seasonal Breeding	Theory	4
		10	B051013T	Neuroendocrine Control of Behavior	Theory	4
			B051014T	Applied Chronobiology	Theory	4

Subject prerequisite

To study Zoology in Post graduate program, student must have studied Zoology in 1st, 2nd and 3rd year of BSc.

Programme Objectives (POs)

1. The Programme has been designed in such a way so that the students get the flavor of both classical and modern aspects of Zoology/Animal Sciences Students are appraised about knowledge of evolution of life and the fundamentals of animal science. They are able to understand complex interactions among living organisms at organisational level.
2. The ultrastructure of cell as a functional unit of life with integral knowledge of complexity oflife is understood by students.
3. Students are sensitized to the environment and related issues. A hand on training on techniques helps students make a choice for career.
4. Skill-based training and hand on training to acquire understanding of biodiversity.
5. Students get aware of their own health and are able to mitigate lifestyle disorders through a better understanding of circadian rhythms.

M.Sc. I	**PSO1**	To empower the students with inquisitive thinking about life and lifeapproaches.
	PSO 2	To analyze the mechanisms involved in life processes up to the molecularlevel.
	PSO 3	To inculcate research specific culture among students.
	PSO 4	To perform the analytical experiments in various fields of biologicalscience.
M.Sc. II	**PSO1**	Capable of identifying scientific questions and potential research areas inZoology.
	PSO 2	To identify a research problem and to formulate a scientific solution.
	PSO 3	In-depth understanding of biodiversity and the challenges to the nation in conservation of wildlife.
	PSO 4	Understand and analyze the ecological and evolutionary significance of different taxa of animals.

Programme/ Class: M. Sc.	Year: Fourth; Subject: ZOOLOGY	Semester: Seventh
Course Code: **B050701T**	**Course Title: Evolutionary and Taxonomic Approaches**	

Course outcomes:

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

1. Understand the principles and methods of taxonomy
2. Understand the evolution of life, Homology and Analogy phylogeny of animals.
3. Students be aware of approaches to study Paleontology i.e. Fossils and its significance
4. To acquire knowledge on the taxonomic status of various animal groups
5. Understand the Origin and development of animals and the Geological time scale

Credits: 4	Core: Compulsory	
Max. Marks: 30+70	Min. Passing Marks: 40% of MM	

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2

Unit	**Topics**	**Total No. of Lectures (60)**
I	Science of taxonomy- Definition, concepts, history, scope and application of biosystematics Zoological Classification – Theories of biological, hierarchies of categories and the higher taxa. Principles, applications and origin of code. Rules of Zoological nomenclature (ICZN),	12
II	Behavioral taxonomy, cytotaxonomy and molecular taxonomy. Concept of Species – Species category, different concepts and intraspecific categories	12
III	Micro and Macro Evolution, Adaptive Radiation and Modification. Fossil & Fossilization. Evolution of Man.	12
IV	Abiotic and Biotic Evolution. Theories of Organic Evolution.Distribution of Animals with Space and Time. Isolating Mechanism. Speciation, Convergent Evolution, Sexual Selection, Natural Selection and Genetics of natural selection.	12

Programme/Class: M. Sc.	Year: Fourth; Subject: ZOOLOGY	Semester: Seventh
Course Code: **B050702T**	**Course Title: Animal Diversity- Non-Chordata**	

Course outcomes:

1. At the end of this course the students will be able to:
2. Understand the Organization of invertebrate Life, Diversity and Phylogeny ofinvertebrates
3. Understand the Outline classification of Animals: Classification of animals.Understand the Levels of structural organization.
4. Analyze the evolutionary relationship of invertebrate taxa
5. To understand the adaptive radiations in early life forms.

Credits: 4	Core: Compulsory	
Max. Marks: 30+70	Min. Passing Marks: 40% of MM	

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2

Unit	Topics	Total No.of Lectures (60)
I	General Organization and classification ofNon chordate phyla up to order level Coelom formation, body symmetry and metagenesis in non-chordates Protozoa: locomotion and reproduction inprotozoa Porifera: skeleton and regeneration in sponges	12
II	Cnidaria: skeleton in coelenterates and coral reefs, Polymorphism Ctenophora: Affinities. Helminths: Parasitism and Parasitic adaptations	12
III	Annelida: Body segmentation and excretory system Arthropoda: Exoskeleton, Respiratory system and larval forms in crustaceans. Mollusca: Torsion and detorsion in gastropod	12
IV	Echinodermata: Skeleton and larval forms and their evolutionary significance. Hemichordata: Affinities	12
V	Minor non-coelomate phyla: Affinities of phylum Rotifer and Acanthocephalan Minor coelomate phyla: Affinities of Chaetognaths, Onychophora, Pogonophora, Phoronida and Brachiopoda.	12

Programme/Class: M. Sc.	Year: Fourth; Subject: ZOOLOGY	Semester :Seventh
Course code **B050703T**	**Course Title: Biochemistry**	

Course outcomes:

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

1. Acquire an understanding of chemical nature of life and life process.
2. Biological structures and importance of molecular interactions and their implication in functional aspects of life.
3. To be able to solve problems based on Biomolecules, pathways, energetics
4. Use current biochemical and molecular techniques to plan and carry out experiments.

Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2

Unit	**Topics**	**Total No. of Lectures (60)**
I	Structure of molecules and chemical bonds, Stabilizing interaction (Vander Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Chemical structure and function of biomolecule carbohydrates, lipids, proteins, nucleic acids and vitamins.	12
II	Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds), Stability of protein and nucleic acid structure. Conformation of nucleic acids(A-,B-,Z-,DNA), t-RNA micro-RNA).	12
III	Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes.	12
IV	Catabolism of carbohydrates, lipids, amino acids and nucleotides Anabolic pathways: Glycogenesis, gluconeogenesis, fatty acid synthesis, cholesterol synthesis, nucleotide synthesis, synthesis of essential amino acids	12
V	Principles of biophysical chemistry (pH, buffer, reaction kinetics thermodynamics, colligative properties). Bioenergetics, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducer.	12

Programme/Class: M. Sc.	Year: Fourth; Subject: ZOOLOGY	Semester: Seventh
Course Code: **B050704T**	**Course Title: Cell and Molecular Biology**	

Course outcomes:

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

1. Understand and explain the basics of cell biology
2. Understand the structural and functional details of the basic unit of life at the molecular level
3. Explain the new developments in molecular biology and its implications in human welfare
4. Understand cellular receptor mechanisms and cell signaling

Credits: 4	Core: Compulsory	
Max. Marks: 30+70	Min. Passing Marks: 40% of MM	

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2

Unit	Topics	Total No. of Lectures (60)
I	Introduction to the cell, cell theory, Ultrastructure of prokaryotic cell and eukaryotic ell organelles – Origin, structure and function of mitochondria, endoplasmic reticulum and ribosomes, Golgi complex, Endosome, (lysosomes, peroxisomes, centrosome). Cell cycle and its control systems	12
II	Bio membrane – Ultrastructure and functions, Transport across membrane. Cytoskeleton, structure and dynamics of microtubules, action filaments(microfilaments), intermediate filaments, cilia & flagella Nucleus – Nuclear envelope, nucleolus. Chromosomes (type,structure chemical composition and functions)	12

Programme/Class: M. Sc.	Year: Fourth; Subject: ZOOLOGY	Semester :Eighth
Course Code: **B050801T**	**Course Title: Environmental & Wildlife Biology**	

Course outcomes:

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

1. Global environmental issues, their causes, consequences and amelioration.
2. To understand and identify behaviors in a variety of taxa.
3. The proximate and ultimate causes of various behaviors.
4. About the molecules, cells, and systems of biological timing systems.
5. Conceptualizing how species profitably inhabit in the temporal environment andspace out their activities at different times of the day and seasons.
6. To interpret the cause and effect of lifestyle disorders contributing to publicunderstanding of biological timing.
7. To understand the importance of wildlife conservation.

Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2

Unit	Topics	Total No. of Lectures (60)
I	Environment: Introduction, Physical environment; Biotic and abiotic interactions, Concept of habitat and niche: Remote sensing and applicability of remote sensing in India	12
II	Populations Dynamic and Community ecology: Characteristics of a population: concept of metapopulation- demes and dispersal, interdemic extinctions, age structured populations. community structure and attributes, levels of species diversity and its measurement: edges and ecotones	12

Programme/Class: M. Sc.	Year: Fourth; Subject: ZOOLOGY	Semester: Eighth
Course Code: **B050802T**	**Course Title: Animal Diversity- Chordata**	

Course outcomes:

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

1. Understand the Organization of vertebrate Life:, Diversity and Phylogeny of vertebrates

2. Understand the Outline classification of Animals: Classification of animals. Understand the Levels of structural organization.

3. Analyze the parallel evolution of vertebrate classes

4. To understand the adaptive radiations in recent life forms.

Credits: 4	Core: Compulsory	
Max. Marks: 30+70	Min. Passing Marks: 40% of MM	

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2

Unit	**Topics**	**Total No. of Lectures (60)**
I	Protochordata: Origin & Evolution of Chordate, General Organization & Affinities of Larvacea. Thaliacea and Cephalochordate.	12
II	Origin and Evolution of Vertebrates General and Comparative Account of Integumentary System and Endoskeleton System	12
III	Fish: General and Special Characters. General Organization and Affinities of Ostracoderm & Coelacanthiformes Amphibia: General and Special Characters. Parental Care, Neoteny	12
IV	Reptiles: General and Special Characters. Adaptive radiation, skull, General Organization of Chelonia Birds: General and Special Characters. Flight Adaptation, Migration and Territorial Behavior	12

Programme/Class: M. Sc.	Year: Fourth; Subject: ZOOLOGY	Semester :Eighth
Course Code: **B050803T**	**Course Title: Animal Physiology & Immunology**	
Course outcomes: At the end of this course the students will be able to: 1. Apply to clinical scenarios the concepts and knowledge of the general terminology, gross anatomy, and physiology of several organ systems (integumentary, skeletal, muscular, and nervous) 2. Understand functional relationships of various organs and organ systems		
Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2		

Unit	**Topics**	**Total No. of Lectures (60)**
I	Digestive & Respiratory system: physiology, Digestion, absorption, BMR. Comparison of respiration indifferent species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.	12
II	Cardiovascular System and Blood circulation: Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG-its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above. Blood corpuscles, hematopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, hemoglobin, immunity, homeostasis.	12
III	Excretory and Nervous system: Comparative physiology of excretion, kidney, urine, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.Neurons, action potential, gross neuroanatomy of the brain andspinal cord, central and peripheral nervous system, Vision, hearing and tactile response.	12

Programme/Class: M. Sc.	Year: Fourth; Subject: ZOOLOGY	Semester :Eighth
Course Code: **B050804T**	**Course Title: Animal Behaviour**	

1. Course outcomes:

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

1. Students acquire knowledge of key concepts and principles and overarching themes in animalbehavior, animal cognition, conservation psychology/biology, animal welfare science.

2. Scientific inquiry and critical thinking

3. Students learn to apply ethical standards in conducting and evaluating psychological research.

4. Students learn communication skills to disseminate research findings, and to applypsychological content and skills to a range of career goals.

Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2

Unit	**Topics**	**Total No. Lectures (60)**
I	Introduction to Animal Behaviour. classification of behavioural patterns, Evolution and ultimate causation, Genetic and environmental components in the development of behaviour. Stereotyped behavior-Taxes, reflexes, instinct and motivation and Conflict behavior	12
II	Learning, memory and Communication - Definition, forms, development and mechanism of learning, neural basis of learning, memory in animals. Study of communication, messages and their meanings, the formsof signals.	12

Programme/Class Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester: Ninth
Course Code: **B050901T**	**Course Title: Genetics & Biostatistics**	
Course outcomes: At the end of this course the students will be able to: 1. acquire a broad understanding of current molecular genetics and genomics including current areasof research 2. provide hands on training on various computational tools and techniques employed in Biologicalsequence analysis; 3. acquire expertise to conduct scientific experiments with statistical validation.		
Credits: 4	Core: Compulsory	
Max. Marks: 30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2		

Unit	**Topics**	**Total No. of Lectures (60)**
I	Fine concept of gene, Mendelism and deviations from mendelian inheritance. Methods of gene transfer – Transformation, conjugation, transduction, bacteriophages-types: structure and morphology of T4 phage	12
II	Molecular anatomy of eukaryotic chromosomes, heterochromatin and euchromatin, sex chromosomes Special chromosomes- giant chromosomes, polytene and lampbrush chromosomes, Concept of recombination, linkage map, levels and significance of gene mapping	12

Programme/Class: M. Sc.	Year: Fifth; Subject: ZOOLOGY	Semester :Ninth
Course Code: **B050902T**	**Course Title: Developmental Biology**	

Course outcomes:

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

1. Understand and explain the basics of cell biology
2. Understand the structural and functional details of the basic unit of life at the molecular level
3. Explain the new developments in molecular biology and its implications in human welfare
4. Understand cellular receptor mechanisms and cell signaling

Credits: 4	Core: Compulsory	
Max. Marks:30+70	Min. Passing Marks: 40% of MM	

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2

Unit	Topics	Total No. of Lectures (60)
I	Theories of development: Introduction, preformation, epigenetic theory, pangenesis theory, recapitulation theory, germplasm theory, mosaic theory, regulated theory, gradient theory and theory of organizers. Regulation in sea urchin egg and *C. elegans*	12
II	Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages: stem cells: genomic equivalence and the cytoplasmic determinants; imprinting mutants and transgenics in analysis ofdevelopment Gametes and fertilization-Spermatogenesis, oogenesis and fertilization	12
III	Early development- Cleavage and blastula, Pattern of cleavage, types of cleavage, effect of yolk on cleavage, physiology of cleavage, morula and blastula Gastrulation-Process of gastrulation. invagination, involution, infiltration, delamination and mechanisms, Accessory processesof gastrulation concrescence and convergence	12

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester :Tenth
Course Code: **B051001T**	**Course Title: Economic & Applied Zoology**	
Course outcomes: At the end of this course the students will be able to: 1. enter into any field of biological and biomedical research provide they have interest in animals 2. They should have good study habits, patience and perseverance. 3. should have the ability to conduct detailed work accurately and methodically.		
Credits: 4	Core: Compulsory	
Max. Marks: 30+70	Min. Passing Marks: 40% of MM	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2		

Unit	**Topics**	**Total No. of Lectures (60)**
I	Animal products – Fish products, dairy products, piggery, pearl, leather and wool. Domestic animals – Poultry, Cattle and Aquaculture, duck and goat farming	12
II	Apiculture, Sericulture, Lac culture, Pearl culture, Prawn culture; pests of common crops likepaddy, cotton, wheat, sugarcane, brinjal, cauliflower, mustard etc. Integrated Pest Management-Chemical and biological Control	12
III	Insect vectors of human diseases & their control (Mosquitos, lice, ticks, flies, bugs and tse – tse fly)	12
IV	Earthworm diversity: Classification, earthworm type: White worm behavior of earthworms as indicators of soil fertility, earthworms as bioreactors, earthworms and plant growth, organic matter dynamics and nutrient cycling, food and feeding habit	12
V	Vermicomposting: Advantages of vermicomposting, vermicomposting in daily life, vermiculture vs vermicomposting, Chemical composition of vermicompost, vermicomposting at home and agricultural farm, Interaction of vermicompost earthworm	12

Programme/Class: Master in Science	Year: Fifth; Subject: ZOOLOGY	Semester : Tenth
Course Code: **B051002T**	**Course Title: Techniques, Biotechnology & Computational Biology**	

Course outcomes:

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

1. Understand the Organization of invertebrate Life, Diversity and Phylogeny of invertebrates

2. Understand the Outline classification of Animals: Classification of animals. Understand the Levels of structural organization.

3. Analyze the evolutionary relationship of invertebrate taxa

4. To understand the adaptive radiations in early life forms.

Credits: 4	Core: Compulsory	
Max. Marks: 30+70	Min. Passing Marks: 40% of MM	

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:3-0-2

Unit	**Topics**	**Total No. of Lectures (60)**
I	Chromatography (paper, thin layer, ion exchange, GLC, HPLC), spectrophotometry, ultracentrifugation, amino acid sequencing, enzyme immobilization.	12
II	Cytometry, flow cytometry, cell fractionation; Light, Electron and Phase contrast microscopy x-ray diffraction, autoradiography, Gram staining	12
III	DNA isolation, Electrophoresis, Microinjection, Electroporation, Hybridization technology, Cloning, PCR, DNA sequencing, FISH, GISH, Chromosome walking, microarray Application of Biotechnology	12
IV	Basic concepts of genetic engineering, vectors, cell & tissue culture. DNA recombination expression in bacterial cell,	12
V	Introduction to Sequence Databases (EMBL, Gene bank). DNA Data Base of Japan (DDBJ), SWISS-PROT, Submitting sequence to	12

redits

		B041011P	Practical lab 4	Core Compulsory	Practical	04
		B041012R	Industrial Training/ Research Project/ Survey	Core Compulsory& Value Added	Project	04

Subject Prerequisites: To study this subject a student must have had the subject(s) Botany at UG Level.

Course Structure: The courses will be based on Choice Based Credit System (CBCS)/ NEP structure developed by the University. There will be four compulsory or elective core courses of Botany in each semester. Apart from these, one minor elective course of other subjects is to be chosen by a student in the first year of M.Sc. (Botany). In each semester, there will be one research project of 04 credits.

Programme (M. Sc.) Objectives:

This programme has been designed to train and enable students to understand the relationship between science and society as well as logical, scientific and ethical issues related to science. In addition to this, the students will be able to think critically for the formulation of hypotheses and experimental designing based on the scientific method, which will make the students readily employable in various streams of teaching, research, civil services and in industries.

Programme Specific Outcomes (PSOs): After completing M.Sc. (with Botany), the following will be the PSOs

PSO-1: It is expected that after successfully completing M.Sc. Botany, students will develop deeper theoretical & Practical knowledge of different branches of Botany like Phytotecnique, Plant taxonomy, Anatomy, Mycology, Microbiology, Physiology, Biochemistry, Cell biology, Genetics, Molecular biology, Medicinal Botany, Pharmacognosy, Environmental issues etc, making them capable of understanding the societal, environmental issues, demands and their solutions.

PSO-2: This program has a strong theoretical basis that will help students in evolutionary relationship of lower and higher plants by using the key characters which is expected from a student of Botany to support the other branches of knowledge related to plants.

PSO-3: Many of the courses in the programme have been carefully designed that will help the students for qualifying competitive exams like IAS, IFS, CSIR NET, SET, TGT, PGT and to write research proposals for grants.

PSO-4: Continuous internal assessment provides ample opportunity to the students for improvement after every evaluation. Seminar and field visits system grooms the personality of the students and enables

them to present oneself with confidence, develop a reasonably well compiled content and discuss. Assignments enable the students to compile the solutions of the given problems with optimal discussion.

PSO-5: In each semester of the programme, each student is given research project of their own choice to allow students to understand various steps of solving a research problem. Thus, this programme will help to develop research aptitude at PG level with identification of gaps in knowledge and relevance of their solutions for the society.

PSO 6. The student completing the course will be capable of executing research projects

Subject : **M.Sc. Botany 1st semester**	
Course Code : B040701T	Course Title : **Microbiology**

Course Objectives: The objective of this course is to make students aware about microbial world and its diversity along with their skill enhancement in microbial application for human welfare and development.

Course Outcomes: By the end of the course, the students should be able to:

1. Address the concepts of microbes and their diversity.
2. Evaluate methods for isolation, purification and cultivation of microorganisms from different sources.
3. Understand classification and growth patterns of bacterial cell.
4. Differentiate between virus, viroids, virusoids and prions.

Credits : 4	Core Compulsory
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Introduction**:Viral genomics and viral proteomics. Viral phylogeny. Viral database. A general account of archaea classification including 16s r-DNA sequencing. Evolutionary aspects of plant microbe interaction. **Growth & Nutrition**: Microbial nutrition, growth kinetics and metabolism	15
II	**Agricultural Microbiology**: Breeding for virus resistance, natural mechanism and transgenic strategies, relevance to Indian agriculture. BNF, Mycorrhiza, Microbial Mineralization, Biocontrol of plant diseases. **Environmental Microbiology**: Biodegradation, Bioremediation, Microbes in nanotechnology, Biosensors.	15
III	**Host Parasite Interaction:** Recognition and Entry process of bacteria and virus into animal and plant host cells, Alteration of host cell and viruses, Virus induced cancers, Two component signalling systems, Chemotaxis, Quorum sensing.	15
IV	**Antimicrobial Substances**: Complement system, Interferons, Iron-binding proteins, Antimicrobial peptides. **Resistance to Antimicrobial Drugs**: Mechanism of resistance in microbes, Antibiotic misuse,. Origin and evolution of virus like- covid-19.	15

Subject : M.Sc. Botany 1st semester			
Course Code : B040702T	Course Title : **Algae, Bryophytes, Pteridophytes and Gymnosperms**		
Objectives: To study phylogeny and inter-relationships of Algae, Bryophyta, Pteridophyta and Gymnosperms **Course Outcomes:** 1. Students will have clear idea of the characteristics of the important plant groups. 2. Concepts in the evolution of plants will be clear to students.			
Credits : 4		Core Compulsory	
Max Marks : 30+70		Min. Passing Marks :	
Total no of Lectures-Tutorials- Practicals (in hours per week):4-0-0			
Unit	**Topic**		**No. of Lectures (60 hrs)**
I	**Algae**: A general account, Phylogenetic definitions, Phylogeny, Classification and apomorphies of Chlorophyta, Charophyta, Phaeophyta Rhodoplantae, Rhodophyta, Cyanidiales, Proteorhodophytina and Eurhodophytina with ecological and economic importance.		15
II	**Bryophyta**: A general account, Phylogenetic definitions, Phylogeny, classification and apomorphies of Hepaticae, Anthocerotae, and Musci with ecological and Economic Importance.		15
III	**Pteridophyta**: A general account, Phylogenetic definitions, Phylogeny, classification and characteristics/apomorphies of Pan-Trachaeophyta, Apo-Trachaeophyta, Trachaeophyta, Pan-Lycopodiophyta, Lycopodiophyta, Pan-Euphyllophyta, Euphyllophyta and Monilophyta. Heterospory, and Soral Evolution.		15
IV	**Gymnosperms**: A general account, Phylogenetic definitions, Phylogeny, classification and apomorphies of Pan-Spermatophyta, Apo-Spermatophyta, Spermatophyta, Pan-Coniferae, Coniferae, Pan-Gnetophyta, Gnetophyta, and Cupressophyta with Economic Importance of Gymnosperms.		15

Suggested Readings:

1. Agashe, S. N. (1995). Paleobotany. Oxford and IBH Publ. Co. Pvt. Ltd., New Delhi.
2. Arnold, A. C. (2005). An Introduction to Paleobotany. Agrobios (India), Jodhpur.
3. Bhatnagar, S. P. and Moitra, A. (1996). Gymnosperms. New Age International, New Delhi.
4. Biswas, C. and Johri, B. M. (1997). Gymnosperms. 4 Narosa Publishers, NewDelhi.
5. Bold, H.C. and Wynne, M. J. (1985). Introduction to the algae; Structure and reproduction. Prentice Hall, Englewood cliffs, New Jersey.

Subject : M.Sc. Botany 1st semester		
Course Code : B040703T	Course Title : Plant Systematics	
Course Objectives: This course aims to add to understanding of the students about basic concepts of plant systematics, clades of Angiosperms **Course Outcomes:** The students will be learning 1. What do we mean by systematics & Cladistics? What are different Types of clade? How to name the clades. Principles &Protologue of Phylocode 2. What are Characteristics, and Classification of Angiospermic clades 3. What are the sources of variations and how speciation takes place? 4. What are the data for molecular systematics. How phylogenetic analysis is carried out. What is DNA barcoding.		
Credits : 4		Core Compulsory
Max Marks : 30+70		Min. Passing Marks :
Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0		
Unit	Topic	No. of Lectures (60 hrs)
I	**Cladistics:** Systematics (concept & definitions), Phylogeny & Ontogeny. Concept of Clade, Grade, Clan, Lineages, & Component of Cladogram. How to read the tree/Cladogram. Clades at different hierarchical level. Identification of Clade, Crown clade, and Total Clade. **Evolutionary concepts:** monophyly, paraphyly, polyphyly, plesiomorphy, apomorphy, anagenesis, cladogenesis, homology, analogy, homoplasy, parallelism and convergence, synapomorphy, symplesiomorphy and Semaphoront. Apomorphies in Angiosperms.	10
II	**Phylocode:** Preamble & Principles (with explanation) of Phylocode. Formulation & Illustrations of Phylogenetic definitions and naming of clades, Specifiers, qualifying clause. Parts of protologue (complete name/clade entry). Comparison of Traditional & Phylocode. **Clades in Angiosperm:** ANA/ANITA grade, Concept of Paleoherbs; Phylogenetic definitions, Phylogeny and Characteristics/apomorphies of following clades: Mesangiospermae; Pan-Angiospermae; Apo-Angiospermae; Angiospermae; Magnoliidae; Monocotyledoneae, Tricolpatae, Eudicotyledoneae, Superrosidae; and Superasteridae.	20
III	**Variation & Speciation:** Isolation: Definitions, classification & Mechanism. Variations: Definitions, Types & mechanism. Speciation: Definitions, causes, types & mode. Origin & Evolution of Flowering Plants.	15
IV	**Data for Plant Systematics:** Morphological & Molecular data. Structure and Role of Chloroplast Genome in Plant Systematics; Mitogenomics and Mitochondrial Genome in Plant Systematics; Nuclear Ribosomal DNA: Structure and uses in Systematics. DNA barcoding.	15

Suggested Readings:

1. Christenhusz, M. J. M., Chase, M. W. and Michael F. F. (2017). Plants of the World: An Illustrated Encyclopedia of Vascular Plants. University of Chicago Press.

Subject : M.Sc. Botany 1st semester	
Course Code : B040704T	Course Title : (a) Applied Mycology

Objectives:

1. To understand the detailed structure of fungus
2. To study the evolution of fungi.
3. To study the economic importance of fungi

Course Outcomes:

1. Students will understand the every aspects of fungi.
2. Students will able to endeavor the arena of mushroom cultivation and be the future entrepreneur.
3. Students will able to use locally available strains of fungi as biocontrol agents.

Credits : 4	Core Elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Diversity of fungi** : General account of fungi, classification of fungi and contribution of scientists, Cultivation, isolation and selection of some useful fungi Common genera – *Saccharomyces, Rhizopus, Penecillium, Erysiphe, Neurospora, Agaricus*	15
II	**Detailed account of fungi**: Isolation and multiplication of mycorrhizae, role in crop productivity and forestry. Phosphate solubilizing fungi. General account of mushroom cultivation –*Agaricus bisporus, Volvariella volvaceae, Calocybe indica.* Medicinal and nutritional value of edible and medicinal mushroom Effect of environmental, nutritional and chemical factors on mushroom cultivation. Genetic improvements in mushroom.	15
III	**Role of fungus in Biotechnology**: Fermentation process and biomass production of fungi, growth kinetics, fermenter systems scale up. Yeast genome: Genetic analysis of yeast, Baker's yeast, food and feed yeast, industrial products (glycerol, adhesive, bio-polymer from yeast). **Economic importance**: Fungi in industry, Fungi in medicine, Fungi in agriculture, Fungi as food.	15
IV	**Fungal pathology**: Disease caused by fungi in plants, Fungi as human and animal parasites, Nematophagus fungi, entomogenous fungi, Exploitation of biocontrol agents by genetic manipulation. Management of fungal diseases.	15

Subject : M.Sc. Botany 1st semester		
Course Code : B040705T	Course Title : (b) **Biostatistics**	

Objective: To study basic of statistics for Biology students.

Course Outcomes: After completion of this course, the students will be able to learn

1. Presentation & Sampling
2. Basics of Correlation and Regression
3. Various test of significance
4. Experimental design for research purposes

Credits : 4	Core Elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials- Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Presentation of Data**: Frequency distributions; graphical presentation of data by histogram, frequency polygon, frequency curve and cumulative frequency curves. **Sampling**: Concept of population and sample; random samples; methods of taking a simple random sample.	10
II	**Correlation and Regression**: Bivariate data-simple correlation and regression coefficients and their relation; Spearman rank correlation; limits of correlation coefficient; effect of change of origin and scale on correlation coefficient; linear regression and equations of line of regression; association and independence of attributes.	15
III	**Tests of significance**: Sampling distribution of mean and standard error; z and t-test (equality of means; paired and unpaired t-test); t-test for comparison of means when variances of two populations differ; Chi-square test for goodness of fit; independence of attributes, and homogeneity of samples; interrelation between t-test and F-Test	20
IV	**Experimental Designs:** Principles of experimental designs; completely randomized, randomized complete block design (missing plot value in RBD); latin square designs; augmented block design; simple factorial experiments (mathematical derivations not required); analysis of variance (ANOVA) and its use including estimation of LSD (CD)	15

Subject : M.Sc. Botany 1st semester		
Course Code: B040706P	Course Title : **Practical Lab 1**	
Objective: To perform 20 experiments from the given list (at least 6 experiments from each units). **Course outcomes:** After completion of this, the students will be able to learn- 1. Isolation and culture of microbes. 2. Vegetative &reproductive part of cryptogams. 3. Taxonomic description and construction of phylogenetic trees.		
Credits : 4		Core Compulsory
Max Marks : 25 Internal +75 External		Min. Passing Marks :
Total no of Lectures-Tutorials-Practical's (in hours per week):0-0-4		

Unit	Topic	No. of Lectures (120 hrs)
I	1. Isolation and maintenance of pure cultures using common microbiological media. 2. Phylloplane microflora- visualization and isolation. 3. Rhizosphere microflora- visualization and isolation. 4. Examination of gram character of bacteria. 5. Methods of isolation and culturing of bacteria or fungi: colony characters; microscopic observations. 6. Study of reproductive structures of different genera of fungi. 7. Study of fungal physiology in pure colonies – characterization of fungal colonies. 8. Study of as many as possible viral, bacterial and fungal diseases of crop plants (cereal, vegetable, fruit, and plantations) from surrounding habitats in Meerut region.	40
II	1. Study of vegetative and reproductive features of important algal groups with the available representatives; Chlorophyta, Charophyta, Euglenophyta, Chrysophyta, Cryprtophyta, Pyrrhophyta, Phaeophyta, and Rhodophyta. 2. Study of vegetative and reproductive features of important bryophyte groups with the available representatives -Hepaticae, Anthocerotae and Musci. 3. Study of vegetative and reproductive features of important Pteridophyte groups with the available representatives: Psilotales, Lycopodiales, Selaginellales, Isoetales, Equisetales, Ophioglossales, Marattiales, Osmundales, Filicales, Marsileales and Salviniales.	40
III	1. Writing of technical descriptions.	40

Semester I

Industrial Training/Research Project/Survey (Value Added)

Course Code:B040707R (Research Project)

Duration: 60 Hrs.

Course Objectives: The objective of this course is to provide students with hands-on training in specialized areas of plant sciences

Course Outcomes: After completion of this course the students will acquire the following:

1. Training in experimental design and execution
2. Knowledge on techniques and tools of research
3. Designing of research proposal.
4. Writing of research work and review paper

Contents

The topic of the research project will be chosen from among the core compulsory courses/core elected courses of that year.

Subject : **M.Sc. Botany 1st semester**	
Course Code: QB040701T	Course Title : **Disaster Management**

Course objectives: To learn management of disaster risk and act with reference to India

Course outcomes: After completion of this course the students will be able to-

1. Gain knowledge about foundations of hazards, disasters, associated natural/social phenomena and disaster management theory (cycle, phases).
2. Understand Indian disaster management system, and role of NIDM.
3. Develops understanding of Methods of community involvement as an essential part of successful DRR, value of humanitarian assistance before and after disaster and technological innovations in Disaster Risk Reduction: Advantages and problems.
4. Take appropriate actions at all points in the disaster management cycle such as preparedness, better warnings, reduced vulnerability or the prevention of disasters during the next iteration of the cycle.
5. Obtain, analyze, and communicate information on risks, relief needs and lessons learned from earlier disasters in order to formulate strategies for mitigation in future scenarios with the ability to clearly present and discuss their conclusions and the knowledge and arguments behind them.

Credits : 4	Minor-Open Elective for other subjects & Value Added
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	Introduction to Disasters: definitions of Disaster, Hazard, Vulnerability, Resilience and Risks. Disasters: Classification, natural hazards and Man-made disasters, Causes, Impacts (including social, economic, political, environmental, health, psychosocial.) Global trends in disasters, urban disasters and climatic change.	15
II	Disaster Risk reduction (DRR): Disaster management cycle-Phases, Disaster risk reduction four pillars of DRR viz (1) Disaster Prevention and Mitigation; (2) Disaster Preparedness; (3) Disaster Response; and (4) Disaster Rehabilitation and Recovery, National Disaster Risk Reduction and Management Council (NDRRMC). Sendai frame work for DRR.	15
III	Organizations of Disaster management: Role and structure of NDMA, NIDM, NDRF, SDRF, SDMA, NPDRR, UNDRR, FEMA and DM Act and Policy, Disaster Response Fund	15
IV	Disasters and Development: Impact of Development projects such as dams, embankments changes in Land-use, Climate Change.	15

Suggested Reading:

1. David, A. (2000). Introduction in Confronting Catastrophe. Oxford University Press.
2. Andharia, J. (2008). Vulnerability in Disaster Discourse. JTCDM, Tata Institute of Social Sciences, Working Paper no. 8.

Subject: **M.Sc. Botany 2nd semester**	
Course Code : B040801T	Course Title : **Genetics**

Course Objectives: The paper will deal with Mendelian and non-Mendelian inheritance

Course Outcome:

The syllabus will provide an understanding of - inheritance of qualitative and quantitative traits.

2. The syllabus will provide an understanding of - the structure and organisation of different components of the eukaryotic genomes.
3. The unit will enable the students to learn about - mapping genes in bacteria and gene regulation in prokaryotes.
4. The syllabus will also provide an understanding of - morphology of chromosomes and its relevance in genetics.-Sex chromosomes and their role in sex determination.-The basic concepts of epigenetics.
5. After completion of this syllabus students will able to crack competitive examinations such as Agriculture Research Services, CSIR, TIFR/NCBS, IISc (Bangalore), GATE, and JRF.

Credits : 4	Core Compulsory
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	Recent advances in Mendelian vs. non-Mendelian inheritance, quantitative and population genetics. Fine structure of gene. Prokaryotic gene regulation- operons, CRISPR-cas, sigma factors, micro RNAs.	15
II	Eukaryotic genome: Components- repeated elements, transposons, organization and evolution. Eukaryotic gene regulation: cis and trans regulation: promoters, transcription factors, post-transcriptional regulation. Higher order structure of chromatin and its role in regulation different biological processes.	15
III	Genetic & physical mapping of genes in eukaryotes: Linkage and crossing over, molecular mechanism of recombination, molecular markers and construction of linkage maps.	15
IV	Cytogenetics and Epigenetics: Molecular structure of centromere and telomere; Sex determination in plants, sex chromosome, chromosomal aberrations. Introduction, methylation, histone modifications, histone code, Genome imprinting, Genome annotation and epialleles.	15

Suggested Readings:

1. Gupta P K (2009). Genetics, 4/e. Rastogi Publications, Meerut.

Subject : **M.Sc. Botany 2nd semester**	
Course Code : B040802T	Course Title : **Cell Biology**

Objectives:

1. To understand the structures and Function of the cell Junction.
2. To understand steps of cell signaling.
3. To understand molecular events during cell cycle.
4. To understand vesicular transport and protein targeting .

Course Outcomes:

1. Students who undergo the teaching of cell biology will develop a solid foundation of knowledge regarding the structure and function of cells.
2. Students will gain in-depth knowledge of Cell Interactions
3. Students will develop a detailed understanding of the functioning of plasma membrane
4. Students will have a comprehensive overview of Cell Cycle Regulation and Signaling Pathways.
5. After completion of this syllabus students will able to crack competitive examinations like GATE and CSIR-JRF

Credits : 4	Core Compulsory
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Cell interactions:** Extra cellular matrix, Cell adhesion molecules; cadherins, integrins, selectins, fibronectins, laminin and Immunoglobin superfamily. Cell-cell adhesions (Junctional and non junctional adhesive mechanisms; occluding junctions, anchoring junctions, communicating junctions (Connexons) and plasmodesmata. **Membrane structure**: Plasma membrane: the lipid bilayer, fluidity of the lipid bilayer, phospholipids, sphingolipids, cholesterol, glycolipids, rafts, Membrane proteins, and membrane transport (Active & Passive).	15
II	**Protein Targeting:** Protein secretion, synthesis and targeting of mitochondria, chloroplast, Nucleus, & Peroxisomes. **Posttranslational Modification of protein:** Glycosylation in the Rough Endoplasmic Reticulum and Golgi Complex. **Vesicular Transport:** Transport From the ER to the Golgi Complex; Transport of Materials through the Golgi Complex; Mechanism of transport to Lysosomes. **Types of Vesicle Transport and Their Functions:** COPII-Coated Vesicles: COPI-Coated Vesicles & Clathrin coated vesicles. **Targeting Vesicles to a Particular Compartment:** Movement, Tethering, Docking & Fusion of Vesicles with target membrane.	15
III	**Cell Cycle**: Overview of Cell Cycle Phases; Cell Cycle Checkpoints; Regulation of cell cycle: **Positive regulation** (Cyclin, Cdk Phosphorylation/dephosphorylation; Activation of cyclin-dependent kinases, Mechanism of Cdk regulation; DNA replication licensing; CDK inhibitors, Maturation promoting factor (MPF) Regulation). **Negative**	15

Subject : **M.Sc. Botany 2nd semester**	
Course Code : B040803T	Course Title : **Developmental Botany**

Course Objectives: To explore the development in plants with pattern and diversity growth, development and reproduction aspects needs to be understood. This course emphasizes on these goals to make the student in depth understanding and evokes curiousness.

Course Outcome: The students after completing this course will become able to:

1. Understand the relevance that how plant development is regulated by genes, environment and hormones.
2. How cell signalling is important for plant development.
3. Understand the molecular mechanism underlaying diverse developmental process involving both vegetative and reproductive organ development
4. Understand the role of epigenetic that regulates development and adaptation.

Credits : 4	Core Compulsory
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Growth regions:** Meristems and their types, Root Apical Meristem (RAM) and Shoot Apical Meristem (SAM) at molecular level, Comparative study of RAM & SAM from lower to higher plants and evolutionary tendencies, Lateral meristem, Intercalary Meristem Programmed cell death and plant development, (molecular mechanism).	15
II	**Plant Reproductive Biology:** Floral evocation and development of the Floral Meristem; Acquisition of floral competence, control of floral identity, regulation by differentiation, physiology, photoperiod and temperature (Molecular level). ABC Model. Structure and development of microsporangium, megasporangium male and female gametophyte (molecular level)	15
III	**Pollen-Pistil Interactions:** Pollen-Stigma Interactions (Pollen Tube Guidance, Pollen recognition by the Stigma Pollen Tube Traffic in the Style and ovule) Self-Incompatibility: Structural and Biochemical Aspects Molecular Aspects of Gametophytic Self-Incompatibility Molecular Aspects of Sporophytic Self-Incompatibility Genes and events involved at Fertilization, Development of dicot and monocot embryo (at	20

Subject : M.Sc. Botany 2nd semester		
Course Code : B040804T	Course Title : (a) **Elementary Biotechnology**	
Course Objectives: This course aims to help the students to attain an advanced understanding of the components of plant biotechnology and will provide an overview of genetic manipulation, its applications, GM crops, etc. **Learning Outcomes:** Upon successfully completing this course, the students could be able to: 1. Conceptualize plant transformation and selection of desirable genes for crop improvement. 2. Design binary vectors and learn the procedure for generating GM crops. 3. Describe GM crops and what products are in the market, their contributions towards food security, sustainable environment and medicine. Evaluate critically the safety issues of GM crops and products in the society		
Credits : 4		Core Elective
Max Marks : 30+70		Min. Passing Marks :
Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0		
Unit	**Topic**	**No. of Lectures (60 hrs)**
I	1. Definition, Basic concepts, Principles and scope of Biotechnology 2. Recombinant DNA technology, basic concept in genetic engineering, tool and techniques of recombinant DNA technology.	15
II	1. Enzymes in genetic engineering - exonucleases, endonucleases, restriction endonucleases, S I nucleases, DNA ligases, polymerase, Kinases, reverse transcriptase and alkaline phosphatase. 2. Gene cloning vectors – primary vectors-Plasmids, Phages, Cosmids, shuttle vectors, 2μ DNA plasmids, Yeast plasmids Transposons, and expression vectors. Recombinant Protein expression, Fermentation and enzyme technology	15
III	Selection of genes, Gene libraries, Genomic and cDNA library - Gene transfer methods, Genetic organization of Ti plasmids, Ti plasmid mediated transfer - *Agrobacterium tumifaciens*, DNA mediated transfer. Calcium phosphate, PEG, DEAE, via liposomes - Microinjection - Macroinjection, microprojectile, and electroporation, - Selection of clones, marker and reporter genes in screening methods. Hybridizations - colony, Southern, Northern, Western Blotting.	15
IV	**1.** DNA fingerprinting, gene therapy and genetic counselling. 2. Use of transposons in genetic analysis: Transposon tagging and its use in identification and isolation of genes. 3. Elementary Knowledge of next generation sequencing. 4. Biosafety regulation: Physical and Biological containment.	15

Suggested Readings:

1. Tropp, B. E. (2012). Molecular Biology. Fourth Edition, Jones and Bartlett India Pvt. Ltd, New Delhi.
2. Howe, C., (2007). Gene Cloning and Manipulation. 2nd Edition.

Subject : **M.Sc. Botany 2nd semester**		
Course Code : B040805T	Course Title : (b) **Pharmacognosy**	

Objectives: To study the fundamentals of Pharmacognosy like scope, classification of crude drugs, their identification and evaluation, phytochemicals present in them and their medicinal properties.

Course outcomes: Upon completion of the course, the student shall be able

1. to know the techniques in the cultivation and production of crude drugs
2. to know the crude drugs, their uses and chemical nature
3. know the evaluation techniques for the herbal drugs
4. to carry out the microscopic and morphological evaluation of crude drug

Credits : 4	Core Elective & Value Added
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	Definition, history, scope and development of Pharmacognosy. Phytochemical and Pharmacological literature review of *Azadirahcta indica, Asparagus Ocimum sanctum, Convolvulus* etc	15
II	Types of Plant drugs from vegetative parts and their Pharmacognostic study a) Root drugs; *Glycyrrhiza* and *Asparagus*, *Coleus, Withania, Catharanthus* b) Rhizome drugs, *Zingiber* c) Leaf drugs, *Andrographis, Clitoria* d) Bark drugs: *Terminalia arjuna, Holorrhena*	15
III	Types of Plant drugs from Reproductive parts and their Pharmacognostic study a) Flower drugs: *Crocus*, *Carthamus*, *Spilanthes* b) Seed drugs: *Piper longum, Mucuna* c) Fruit drugs: *Carum cuminum, Emblica, Cassia.*	15
IV	Evaluation of the drugs; Organoleptic, Microscopic, Physical, Chemical and Biological methods of evaluation A brief account of various drug constituents: Carbohydrates, Cardiac glycosides, alkaloids, flavinoids, Tannins volatile oils, resins quinines and steroids with particular reference to *Acacia* gum, *Phyllanthus*, *Coleus, Asparagus, Rauvolfia*	15

Suggested Books

1. Evans, W. C. (2009). Trease and Evans Pharmacognosy. 16th edition, W.B. Sounders & Co., London.

2. Ali, M. (2020). Pharmacognosy and Phytochemistry, CBS Publishers & Distribution, New Delhi.

Subject : **M.Sc. Botany 2nd semester**	
Course Code : B040806T	Course Title : (e) **Applied Phycology**

Objective: To study commercial production and utilization of algae

Course Outcome: After completion of this course the students will be able to learn

1. Mass cultivation of algae
2. Controlling of biofouling of ships.
3. Hydrogen production by algae.
4. Production of biofertilizer

Credits : 4	Core Elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	A brief account on genetic metabolic understanding in microalgae. Algae in environment: Bioremediation, Carbon sequestration, waste water treatment. Value added product derived from microalgae. Hydrogen and biofuel production from algae.	15
II	**Microalgae in liquid waste treatment and reclamation**. Biological waste treatment system, Design consideration (Algal concentration, algal productivity) Operation of integrated algal bacterial system, current application, future application (Sewage grown algae, energy system, toxin removal. Algal toxins in aquatic environment.	15
III	Isolation, purification, development of unialgal cultures and culturing of microalgae Single cell protein from *Spirulina, Dunaliella* and *Chlorella*, desiging of photobioreactor and algal cultivation in photobioreactor. Algal Transgenics and Biotechnology	15
IV	Paddy field cyanobacteria: Qualitative and quantitative assessment of their biodiversity using molecular tools; their use as biofertilizer, reclamation of usar lands. Influence of salt, heavy metals and acid rain on algae: Physiological and biochemical effects; biochemical and molecular mechanisms of tolerance.	15

Suggested Readings:

1. Car, N. G. and Whitton, B. A. (1982). The Biology of Cyanobacteria. Blackwell.
2. Rai, L. C., Gaur, J. P. and Soeder, C. J. (1994). Algae and Water Pollution.Schweizerbart'sche Stuttgart, Germany.

Subject : **M.Sc. Botany 2nd semester**	
Course Code : B040807T	Course Title : (d) **Stress Physiology of Plants**

Objective: Objective: This course aims to educate student on concepts of various types of stresses in crop production and strategies to overcome them.

Learning Outcome:

1. The students will understand various aspects of stress physiology such as physiological and molecular basis of abiotic and biotic stress tolerance in plants.
2. The knowledge in stress physiology will be useful for developing climate resilient genotypes for sustainable crop production.
3. Student also able to explain what basic processes and/or traits are affected by each one of the stresses.
4. Explain how the plant tissue responds at the biochemical and molecular level to each one of the stresses.

Credits : 4	Core Elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	Biological stress vs. Physical Stress, Types of stresses and general methods of measurement of stress response (Strain), Stress physiology in crop improvement, Response to UV stress: Injury and resistance mechanism	15
II	Response to low temperature stress: Chilling, freezing, frost injury and mechanism of resistance, Adaptations, Response to high temperature stress: Injury and mechanism of resistance, Heat shock proteins, Adaptations	15
III	Response to nutrient deficiency stress, Heavy metal stress, injury and mechanism of resistance, adaptations, Salinity stress, Ionic and salt stress injury, mechanism of resistance	15
IV	Response to water deficit: Desiccation, Dehydration injury; Mechanism of resistance, Adaptations, Response to water excess. Causative agents for Biotic Stresses, Mechanism of Resistance against Fungal, Bacterial and viral pathogens	15

Subject : **M.Sc. Botany 2nd semester**		
Course Code: B040808P	Course Title : **Practical Lab 2**	
Objective: To perform 20 experiments from the given list (at least 6 experiments from each units). **Learning Outcomes:** On completion of this course, the students will be able to study cell division, cell's type, genetical experiments & experimental related to developmental botany.		
Credits : 4	Core Compulsory	
Max Marks : 30+70	Min. Passing Marks :	
Total no of Lectures-Tutorials-Practical's (in hours per week):0-0-04		

Unit	Topic	No. of Lectures (120 hrs)
I	1. Exercise based on Mendelian experiments (monohybrid, dihybrid and test cross). 2. Exercise based on gene mapping. 3. Exercise based on gene regulation 4. Laboratory exercises in probability and chi-square; 5. Chromosome mapping using three-point test cross 6. Study of co-dominance. 7. Study of lethal allele 8. Study on different gene interaction (Epistasis) 9. Numerical exercise on multiple factor hypothesis	40
II	1. Mitotic studies in suitable material: Squashing of the root tip and selection of metaphase plate. 2. Mitotic studies in suitable material: Camera Lucida drawing, Karyotype analysis, ideogram and derivation of karyotypic formula. 3. To study chromosomal aberrations in *Rheo* spp. 4. Meiosis in *Allium cepa*. 5. To measures the cell's size. 6. To study cell's inclusion. 7. To study different cell's types and their camera lucida drawing. 8. Histochemical analysis of the following chemical compounds: a) Alkaloids b) Steroids c) Quinones d) Resins e) Glucosides f) Pigments g) Volatile oils. 9. Organoleptic evaluation of the following: a) *Glycyrrhiza* (Root) b) Ginger (Rhizome) c) *Eucalyptus* (leaf) d) *Terminalia arjuna* (Bark) f) *Strychnos nux-vomica* (seed). 10. Powder analysis. a) Curcuma b) Cloves c) Senna d) Fennel e) Cinnamon: Market drugs: a) Turmeric b) Chillies c) Coriander d) Wheat and Jowar.	40
III	1. Comparative anatomy of monocotyledon and dicotyledon root, stem and leaf. 2. Anatomical basis of identification C3& C4 sub types in grasses. 3. Phytoliths of grasses and their potential use in identification. 4. Anatomy of lenticels and periderm in plants.	40

Semester 2

Industrial Training/Research Project/Survey(Value Added)

Course Code: B040809R (Research Project)

Duration: 60 Hrs.

Course Objectives: The objective of this course is to provide students with hands-on training in specialized areas of plant sciences

Course Outcomes: After completion of this course the students will acquire the following:

1. Training in experimental design and execution
2. Knowledge on techniques and tools of research
3. Designing of research proposal.
4. Writing of research work and review paper

Contents

The topic of the research project will be chosen from among the core compulsory courses/core elected courses of that year.

Subject : **M.Sc. Botany 2nd semester**	
Course Code:QB040801T	Course Title : **Fascinating Plants**

Course Objectives:
The course aims to have understanding of Plant & Religion, strange & Economic important Plants.

Course Learning Outcomes:
The students will be learning?

1. What are the sacred plant?
2. What are morphological modifications, adaptation on plants?
3. What are economic important plants?
4. What are conservation strategies of threatened taxa?

Credits : 4	Minor-Open Elective for other subjects
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Plants & Religion:** Tree worship in Vedic Period, Puranas, Buddhism & Jainism; Plant & Astrology; Sacred Groves; Venerated plants of your locality. Plantsin Worship,Myths, Plants in Epic like Mahabharata, Ramayana.	15
II	**Plants with Unique Morphology**: *Welwitschia*, Cacti, Orchids, *Wolffia, Rafflesia, Sepria, Sequoia* & it allied Taxa, *Victoria amazonica, Amorphophallus*, Baobab (*Adansonia*), *Selaginella lepidophylla,* Dancing Grass (*Desmodium gyrans*), *Mimosa pudica*; Insectivorous plants (*Dionaea, Nepenthes, Drosera, Utricularia* etc Parasitic Plants.	15
III	**Economic important Plants**: Ornamental, Medicinal, poisonous & Timber yielding plants of your Locality.	15
IV	Special pollination mechanisms (*Ficus, Calotropis, Ophrys, Salvia*), Signature Plants & Plants that thrills (Stumulants, Depressants etc), Conservation of Rare, Endangered and threatened plants, Exotic & Invasive Plants.	15

Subject: **M.Sc. Botany 3rd semester**		
Course Code : B040901T	Course Title : **Medicinal Botany and Ayurvedic System of Medicine**	
Objectives: To acquire knowledge on the methods of preparation and use of formulations of various systems of medicines. **Course Outcomes**: The students will be able to learn principles and concepts of alternative systems of medicine like ayurvedic medicine. Besides the students will also be able to learn knowledge on the methods of preparation and use of formulations of various systems of medicines.		
Credits : 4	Core Compulsory & value added	
Max Marks : 30+70	Min. Passing Marks :	
Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0		
Unit	**Topic**	**No. of Lectures (60 hrs)**
I	Introduction to various systems of Indigenous Medicine. Introduction to basic concepts of folk medicine and Ayurveda. Principles and Concepts of Ayurveda, History and Development of Ayurvedic medicine.	15
II	**Study of some Ayurvedic drugs & Their Plant sources**: Haldi, Guggul, Ashoka, Shatavar, Sarapgandha, Kalmegh, Gokhru, Punarnava, Ashwagandha, Jatamansi, Isabgol, Vasaka, Shilajit, Neem, Curry Patta, Giloe, Kachnar, Arjun, Harad, Bahera, Amla, Amaltas, Banyan, Tulsi, Sadabahar and mint.	15
III	Role of plants in medicine. Morphology, active principles and medicinal value of the following: *Andrographis paniculata, Moringa oleifera, Clitoria ternata Phyllanthus emblica* and *Gymnema sylvestre* Plant secondary metabolite of medicinal importance: alkaloids, glycosides, mucilage, sterols. Some common herbal practices used to cure – fever, worms, diarrhea, cough, cold, Arthritis, rheumatism, stone in urinary tract, eczema or fungal infections.	15
IV	Introduction to Ayurvedic formulations with methods of preparation & Uses: Churna, Vati, Avleh, Asava, Arishta, Taila and Bhasma. **Ayurvedic Products:** Triphala, *Chyawanprash,* Ghutti, etc Knowledge of ancient equipment like khalwa yantra, Arka yantra, Patana yantra	15

Suggested readings

1. Awadesh, N., Ghoeami, A. and Sharma, R., Indigenous Health Care and Ethnomedicine, Sarup and Sons.
2. Glimpses of Indian Ethano-Pharmacology by P. Pushpangadam. Ulf Nyman. V. George Tropical Botanic Garden & Research Institute.
3. Textbook of Pharmacognosy by C. K. Kokate, Purohit, Ghokhale, Nirali Prakashan.
4. Ayurvedic formulary of India, Govt. of India

Subject : **M.Sc. Botany 3rd semester**	
Course Code : B040902T	Course Title : **Plant Biochemistry and Molecular Biology**

Objective: This course aims to educate student on concepts of proteins, enzymes, basic plant signaling mechanisms, sensory photobiology. The course further deals with plant secondary metabolites and plant-plant interaction.

Course Outcomes:

1. Impart an insight into the various biochemical and molecular mechanism of plant biology.
2. Take students to higher levels of biochemical and molecular learning about plant system.
3. Understand the biochemical and molecular role of various biomolecules.
4. Acquire knowledge about signal transduction and sensory photobiology.
5. After completion of this syllabus students will able to crack competitive examinations such as Agriculture Research Services, CSIR, TIFR/NCBS, IISc (Bangalore), GATE, and JRF

Credits : 4	Core Compulsory
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	**No. of Lectures (60 hrs)**
I	Thermodynamics, Protein structure and Enzymes: Application of principles of thermodynamics in biology; enzyme kinetics and inhibition of enzymatic activity. Hierarchical structure of proteins; purification of protein via chromatography, precipitation and antibody.	15
II	Signal Transduction: Signalling mechanisms of plant hormones viz. auxin, cytokinin and ethylene.	15
III	**Sensory Photobiology**: Molecular Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; Light induced stomatal movement; Molecular events during scotomorphogenesis and photomorphogenesis.	15
IV	Molecular structure of Secondary metabolites, Natural products (secondary metabolites), their range and eco-physiological functions. Overview of terpenoids, alkaloids, and phenolics.	15

Suggested Readings:

1. Buchanan, B., Gruissem, G. and Jones, R. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, USA.
2. Davies P. J. (2004). Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.

Subject : **M.Sc. Botany 3rd semester**	
Course Code : B040903T	Course Title : **Environmental Chemistry**

Objective: To impart the students about the environment that he/she can put across bills and policies that can help protect the world from disasters such as Global Warming, Climate Change and to keep its country eco-friendly.

Course Outcome: Upon successful completion of the course the student will be able to:

1. Classification of elements, composition of air, the characteristics of hydrocarbons, biogeochemical cycles, pesticides, and their effects
2. Demonstrate knowledge of chemical and biochemical principles of fundamental environmental processes in air, water, and soil.
3. Recognize different types of toxic substances & responses and analyze toxicological information.
4. Describe causes and effects of environmental pollutant by and discuss some mitigation strategies.
5. Get job as Water Treatment Specialist in Water Treatment and Waste Disposal, Environmental Assessment Analyst, Environmental Auditor, Chemist, Environmental Consultant, Government Scientist (Provincial and Federal), Research Associate in Universities, Environmental Health & Safety Coordinator in Chemical Product Distributors, Quality Assurance in Manufacturing (Food, Paper, Chemical, Plastics), Analytical Specialist in Engineering Consulting and crack UGC NET

Credits : 4	Core Compulsory
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	Environmental Chemistry Fundamentals of Environmental Chemistry: Classification of elements, Stoichiometry, Gibbs' energy, chemical potential, chemical kinetics, chemical equilibria, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radioisotopes.	15
II	Composition of air. Particles, ions and radicals in the atmosphere. Chemical speciation. Chemical processes in the formation of inorganic and organic particulate matters, thermochemical and photochemical reactions in the atmosphere, Oxygen and Ozone chemistry. Photochemical smog.	15
III	Hydrological cycle. Water as a universal solvent. Concept of DO, BOD and	15

Subject : **M.Sc. Botany 3rd semester**	
Course Code : B040904T	Course Title : (a) **Genetic Engineering**

Course Objectives: The aim of this course is to provide a profound knowledge on the methods used in Genetic Engineering allows students to apply these in basic and applied fields of biological research in an innovative way.

CourseOutcomes: Upon successfully completing this course, the students could be able to:

1. Outline the basic steps in genetic engineering. Describe the mechanism of action and use of restriction enzymes.
2. Describe the techniques used to probe DNA for specific gene of interest and also the technique used to study gene expression.
3. Conceptualize the basics and applications of genomics, proteomics and bioinformatics.
4. Discuss the methods of protein sequencing, protein and metabolic engineering and their future prospects.
5. Explain the usefulness of RNA interference and its potential for crop improvement.
6. Outline the fundamentals of genome editing.

Credits : 4	Core Elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	Genetic Engineering (General), Restriction mapping, Restriction of Chimeric DNA- staggered cleavage, addition of oligopolymer tailing & linkers, blunt end ligation.Gene sequencing (principle & different techniques), c-DNA & genomic libraries.	15
II	**DNA analysis**: Labelling of DNA & RNA probes, southern & florescence in-situ hybridization, DNA fingerprinting, chromosome walking. **Techniques for gene expression**: Northern & western blotting, gel retardation technique, DNA footprinting, primer extension, S1 mapping, reporter assays.	15
III	Proteomics as a tool for plant genetics, breeding & diversity studies. Protein extraction/ purification techniques viz electrophoresis & column chromatography. Protein sequencing methods, detection of post translational modifications of proteins, methods of analysis of gene expression at RNA and protein level, large scale expression such as Microarray based techniques. Protein Engineering and metabolic engineering- definition and explanation, Steps, Achievements and future	15

Subject : **M.Sc. Botany 3rd semester**	
Course Code : B040905T	Course Title : (b) **Evolutionary Biology**

Course Objectives: The objective of the course is to provide an understanding of the trends inchanges occurring in living organism over period of time through various process and pattern.

Course Outcomes: Students will be able to grasp understanding of:

1. Evolution and its relevance in biological organism
2. How evolution works (Patterns and trends).
3. Learn how to study evolution and what are evolutionary processes.
4. develop ability to incorporate knowledge of evolution in other streams of study.

Credits : 4	Core Elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Introduction** - Pattern and process components of scientific theories: biological variation and evolutionary change (evidence for evolution). Darwin and Wallace – natural selection, adaptation. Microevolution, macroevolution. Evolutionary history: reading trees, monophyly, Tree of life. Evolutionary trends: maximum parsimony, origin and evolution of traits across life and green plants.	20
II	The fossil record. Geological fundamentals. Phylogeny and the fossil record. Evolutionary trends. Rates of evolution. The geography of life. Major patterns of distribution. Historical biogeography, phylogeography.	10
III	The Modern Synthesis: Population Genetics. Forces of evolution: Genetic drift – Sampling error; Mutation. Migration/Gene Flow. Adaptation – Fitness, coefficient of selection. Onelocus models, multi-locus models, modes of selection. Non adaptive traits. Molecular evolution. Neutral theory. Molecular clock. Testing for selection. Modes of selection. Pairwise distances and molecular divergence. Molecular models.	15
IV	Species. Reproductive isolation. Species concepts and processes of speciation. Drivers of speciation. Geographic patterns. Evolutionary mechanisms. Post-zygotic and pre-zygotic isolation in allopatry and sympatry, reinforcement, character displacement. Hybrid speciation,	15

Subject : **M.Sc. Botany 3rd semester**	
Course Code : B040906T	Course Title : (c) **Plant Nomenclature**

Course Objectives:

This course aims to add to understanding of the students about International code of Nomenclature for algae, fungi & Plants

Course Outcomes:

The students will learn

1. What are different methods of naming plants? What are different principles & Rules of nomenclature? Why name changes?

Credits : 4	Core Elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	Polynomial System of Nomenclature. Binomial System of Nomenclature, Uninomial System of Nomenclature. History and Development of the Code of Botanical Nomenclature, Important dates in the *Code*, Structure and organization of the *Code*. How to publish a new name.	15
II	Principles of ICN and their explanation. Ranks & Taxa: Ranks and Nomenclature of Taxa. Type Method, How to designate a type? Principle of Priority and Its Limitations, How to find the correct name for a taxon? Effective and Valid Publication	15
III	Citation, How to cite names of authors? Conservation, Protection, Retention of Names and Epithets of Taxa, Choice of Name, Rejection of Names and Epithets, suppressed works, and binding decisions, Nomina Conservanda	15
IV	Orthography of Names, How to spell names? Nomenclature of Hybrids and Cultivated Plants Publication of a New Species How to change the *Code*?	15

Suggested Readings

1. Turland et al. (2018). International code of nomenclature for algae, fungi and plants.
2. Turland, N. (2019). The Code Decoded, A user's guide to the international code of nomenclature for algae fungi & plants. Pensoft Publisher.

Semester 3

Industrial Training/Research Project/Survey(Value Added)

Course Code: B040908R (Research Project)

Duration: 60 Hrs.

Course Objectives: The objective of this course is to provide students with hands-on training in specialized areas of plant sciences

Course Outcomes: After completion of this course the students will acquire the following:

1. Training in experimental design and execution
2. Knowledge on techniques and tools of research
3. Designing of research proposal.
4. Writing of research work and review paper

Contents

The topic of the research project will be chosen from among the core compulsory courses/core elected courses of that year.

Subject : **M.Sc. Botany 4th semester**	
Course Code : B041001T	Course Title : **Environmental Issues and Policies**

Objectives: To study environmental issues at global level

Course outcomes: After completion of this course the students will be able to learn-

1. The causes of global climate change.
2. Understand the causes of global water & energy crisis
3. National policies on environment
4. Causes of biodiversity loss

Credits : 4	Core Compulsory
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Environmental Pollution**: Causes and effects of air, water, soil, noise, radioactive pollution; Basic pollution abatement practices and technologies **Global Change**: Global land cover and land use change; Multiple impacts of land use change; Causes, effects and mitigation strategies for global climate change and stratospheric ozone loss	15
II	**Biotic Invasions**: Extent and mechanisms of biological invasions; Ecological and economic impacts; Management strategies. **Loss of Biodiversity**: Threats and pattern of biodiversity loss; Natural and anthropogenic causes; IUCN threat categories, Red data books; Conservation and restoration of biodiversity	15
III	**Global Water Crisis**: Distribution, withdrawal and consumption patterns; Causes and effects of water crisis; Water conservation approaches. **Global Energy Crisis**: Sources of energy supply; Current potential and future prospects of energy sources; Energy crisis; Energy conservation strategies	15
IV	**Challenges of Urbanization**: Trends of urbanization; Environmental impact of urbanization; Concept of green cities. **National Policies on Environment**: National Forest Policy; National Water Policy; National Energy Policy; National Action Plan on Climate Change; National Biodiversity Action Plan.	15

Subject : M.Sc. Botany 4th semester		
Course Code : B041002T	Course Title : **Ethnobotany & Intellectual Property Rights**	
Course Objectives: This course will provide the necessary introduction about ethnobotany & IPR **Course Outcomes:** Students will be able to grasp understanding of: 1. Ethnobotanical studies in India and what is ethnobotany 2. What are IP rights, their types and how they are connected with biological resources, ethnobotanical knowledge and can it be used to protect/conserve resources, rights of people and prevent biopiracy. 3. Utility of ethnobotanically important plants		
Credits : 4		Core Compulsory
Max Marks : 30+70		Min. Passing Marks :
Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0		
Unit	**Topic**	**No. of Lectures (60 hrs)**
I	**Introduction**; a brief history of ethnobotanical studies in the world and in India; scope of ethnobotany. Subdisciplines of ethnobotany	10
II	**Origin, utilization, cultivation and uses of plants**: food, forage and fodder crops; fiber crops; vegetable oil-yielding crops; timber-yielding plants; non-wood forest products (NWFPs) such as bamboos, rattans, raw materials for paper making, gums, tannins, dyes, resins and fruits	20
III	**Intellectual Property Rights**: Concept, types, Need and Relevance of IPRs, National IPR Policy International IP regimes: WTO-TRIPS and other key international legal instruments **Copyright:** concept, Subject matter of Copyright, Term, ownership, moral rights, infringement, remedies, defence/fare uses. Patent: History, Patentability Requirements, Patent Specification, Patent Procedure, Infringement, Defence, Remedies.	10
IV	Traditional knowledge and utility of some medicinal plants in UP & Neighbouring states – *Solanum trilobatum, Cardiospermum halicacabum, Vitex negundo, Adathoda vasica, Azadirachta indica, Gloriosa superba, Eclipta alba, Aristolochia indica, Phyllanthus fraternus* and *Boerhaavia diffusa.*	20

Suggested Readings:

Subject : **M.Sc. Botany 4th semester**	
Course Code : B041003T	Course Title : (a) **Biophysical Chemistry**

Objective Developing of general understanding how physical laws govern biological processes and acquire basic knowledge about how physical methods can be applied to understand biological processes.

Course Outcome:

On completion of the course, the student should be able to:

1. Account for the different interactions that are important for the formation of structures in biological systems and for how thermodynamic parameters can be measured.
2. Account for basic concepts of laboratory reagents preparation and their uses.
3. Account for functions of biological buffer system and titration of acid and base.
4. Explain and apply methods for the determination of functional molecular mass of biological macromolecules in solution as well as determination of equilibrium - and rate constants for macromolecule-ligand interactions.
5. Students will be able to qualify CSIR NET, GATE and other entrance examinations.

Credits : 4	Core elective,
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Solution:**Normality, molarity and molality of the solution, ppm and percent solutions, colligative properties of electrolyte solution: the Donnan effect.	10
II	**Acid and Bases:** Definition of acid and base, acid-base properties of water, concept of pH and pK_a, acid (amino acids) and base titration, diprotic and polyprotic acids, preparing a buffer solution with specific pH, dissociation of amino acid, isoelectric point, titration of protein.	10
III	**Bioenergetics:** Concept of free energy, standard free energy, determination of ΔG for a reaction. Relationship between equilibrium constant and standard free energy change, biological standard state & standard free energy change in coupled reactions, Gibbs energy of biological membrane transport. Biological oxidation-reduction reactions, redox potentials, relation between standard reduction potentials & free energy change. High energy phosphate compounds: introduction, phosphate group	20

Subject : M.Sc. Botany 4th semester		
Course Code : B041004T	Course Title : (b) **Bioentrepreneurship and Innovation**	
Objectives: Impart knowledge and work experience based/case study based training to students in the field of innovation and uses of various biology/ biotechnology based products, goods, services employed in bioentrepreneurship. **Course Outcomes**: 1. To be able to prepare a business plan and launch career as bioentrepreneur. 2. Being able to get employment in a bioindustry or a bioconsultancy		
Credits : 4		Core elective; (b) Value added, & Entrepreneurship
Max Marks : 30+70		Min. Passing Marks :
Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0		
Unit	**Topic**	**No. of Lectures (60 hrs)**
I	1. Entrepreneurship in the Life Sciences. 2. Development of Products in the Biomedical Industry. 3. Integration of science, technology and business. 4. From Lab to land: scope in agro/food processing industry 5. Industrial management. 6. Market analysis. 7. Business development. 8. Regulatory mechanisms. 9. Indian bioentrepreneurial scenario. 10. Case studies of successful bioentrepreneurs.	Each part will be of 6 hours

Suggested Readings:

1. Rhonda, A. (2010). Six-Week Start-Up: A Step-by-Step Program for Starting Your Business, Making Money and Achieving Your Goals! Redwood City: The Planning Shop.

2. Byrne, J. A. (2011). World Changers: 25 Entrepreneurs Who Changed Business as We Knew it. New York: Penguin.

3. Edwards, S. and Edwards,P. (1999). Working from Home: Everything you need to Know about Living and Working under the Same Roof. New York: Penguin Putman.

4. Bruce, J. (2004). Go it alone! The Secret to Building a Successful Business on Your Own. New York: HarperCollins.

Subject : M.Sc. Botany 4th semester		
Course Code : B041005T	Course Title : (c) **Molecular Systematics and Phylogenomics**	
Objectives: To understand concepts of phylogenomics and Molecular evolution **Course Outcomes:** After completion of this course the students will be able to learn 1. Analyse phylogeny and phylogenetic analysis using molecular data 2. Construct cladogram 3. Phylogenetic software		
Credits : 4		Core elective
Max Marks : 30+70		Min. Passing Marks :
Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0		
Unit	**Topic**	**No. of Lectures (60 hrs)**
I	**Phylogenomics**: Phylogenomics and the tree of life, data used in Phylogenomics, Steps and tools in Phylogenomics, Phylogenomic reconstruction, Methods of phylogenomic inference. Approaches of Phylogenomics.	15
II	**Molecular Evolution:** Concepts of Neutral Evolution and Evolution at Molecular Level, Molecular Clocks; Evolution of Gene and Genome; The RNA World: Origin of Life; Homology: Orthology, Paralogy & Xenology.	15
III	**Phylogenetic Systematics/Cladistics:** *Cladogram Construction*: Apomorphy, Recency of Common Ancestry, Monophyly, Parsimony Analysis, Unrooted Trees, Evolutionary trees & rooting; Character & Tree Optimization (Acctran & Deltran), Polytomy, Reticulation, Taxon Selection and Polymorphic Characters, Polarity Determination: Outgroup Comparison, Ancestral versus Derived Characters,	15
IV	**Phylogenetic Analysis:** Consensus Trees (Consistency Index, Retention Index, Bremer Support (Decay Index), Bootstrap Analysis), Long Branch Attraction, Maximum parsimony, Maximum Likelihood, Bayesian Analysis, Measures of Homoplasy, Cladogram Robustness.	15

Suggested Reading

1. Bleidorn, C. (2017). Phylogenomics: An Introduction. Springer.
2. Crawford, D. J. (1990). Plant Molecular Systematics: A Macromolecular Appproach. John Wiley & Sons.
3. Judd, W. S, Campbell, C. S., Kellog, E. A., Stevens, P. F. and Donoghue, N. J. (2013). Plant Systematics – A phylogenetic approach. SinauerAssociates, Inc, Massachusetts, USA.
4. Trivedi, S., Rehman, H., Saggu, S., Panneerselvam, C. and Ghosh, S. K. (2018). DNA Barcoding and Molecular Phylogeny. Springer
5. Soltis, D. E., Soltis, P. S., Endress, P. K. and Chase, M. W. (2005). Phylogeny and Evolution of Angiosperms. SinauerAssociates, Inc, Massachusetts, USA.

Subject : M.Sc. Botany 4th semester	
Course Code : B041006T	Course Title : (d) **Nanobiotechnology**

Objectives: This course aims at developing sound knowledge of scope of nanbiotechnology in biological systems, their properties, techniques used in nanobiotechnology, and its applications in medical and agricultural fields.

Learning Outcomes: By the end of the course, the students should be able to:

1. Studying the basics and scope of nanobiotechnology.
2. Acquiring theoretical knowledge of applications of nanoparticles in medicine, agriculture and environment.
3. Describes the various techniques used for characterization of nanoparticles.
4. Learn about the potential hazards of nanoparticles.

Credits : 4	Core elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	Introduction to Nano biotechnology and its scope, history of nanobiotechnology, nanobiomaterials, challenges for nanobiotechnology, synthesis of nanoparticles. Microbes for the evaluation of nanomaterial toxicity.	15
II	Properties and characterization of nanoparticles- 1) Optical (UV-Vis/ fluorescence), 2) X-ray diffraction 3) Size and imaging- electron microscopy, light scattering. 4) Surface and composition- EDAX, AFM/STM. 5) Vibrational FT-IR and Raman spectroscopy.	15
III	Interaction of nanomaterial and biosystem (protein, nucleic acid, carbohydrates and lipids). Nanomaterial- cell interaction.	15
IV	Nanobiotechnology and its applications in agriculture. Nanobiotechnology and its applications in medicine and pharmaceuticals. Microbes in nanobiotechnology; production of nanoparticles using bacteria. Nanotoxicology- nanoparticles and their potential toxicity in organisms/ toxicity and environmental risks of nanomaterials.	15

Suggested Readings:

1. Charles (Jr.), P. P. and Owens, F. J. (2003). Introduction to Nanobiotechnology.
2. Niemeyer, C. M. and Mirkin, C. A.,(2004). Nanobiotechnology: Concepts, Applications and Perspectives.
3. Donovan, R. (2016). Application of Nanotechnology in Drug Delivery.
4. Varghese, T. and Balakrishna, K. M. (2021). Nanotechnology: An Introduction to Synthesis, Properties and Applications of Nanomaterials.

Subject : M.Sc. Botany 4th semester	
Course Code : B041007T	Course Title : (a) **Glycobiology**

Objective:

1. To study chemistry of carbohydrates, the enzymology of glycan formation and degradation,
2. To study the recognition of glycans by specific proteins (lectins and glycosaminoglycan-binding proteins), glycan roles in complex biological systems, and their analysis or manipulation by a variety of techniques.

Course Outcome

1. Be able to understand the role of glycans in biosphere and biotechnology.
2. Being able to understand role of glycans in health and disease and medicinal field.
3. Having Prospects to work in pathology andhematological laboratories.

Credits : 4	Core elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**General Principles:** Historical Background and Overview, Saccharide Structure and Nomenclature, Exploring the Biological Roles of Glycans.	10
II	**Biosynthesis, Metabolism, and Function**: Monosaccharide Metabolism, N-Glycans, O-Glycans, Glycosphingolipids, Glycophospholipid Anchors, Proteoglycans and Glycosaminoglycans, Sialic Acids, overview of Glycosyltransferases, Degradation and Turnover of Glycans, Bacterial Polysaccharides.	20
III	**Protein-Glycan interactions:** Discovery and Classification of Animal, Plant and fungal Lectins, Selectins, Galectins, Microbial Carbohydrate-binding Proteins, Plant Lectins, their Classification , Structure, Uses and functions; Fungal lectins, their structural diversity, biological functions, molecular characterization.	20
IV	**Methods and Applications**: Principles of Structural Analysis and Sequencing of Glycans, Chemical and Enzymatic Synthesis of Glycans, Natural and Synthetic Inhibitors of Glycosylation, Glycobiology in Biotechnology and Medicine	10

Suggested Readings:

Subject: **M.Sc. Botany 4th semester**	
Course Code: B041008T	Course Title : (b) **Plant Tissue Culture**

Objectives: The course aims at applied aspects of plant tissue culture. After completing this course the students should be able to:

1. Define the basic concepts of plant tissue culture.
2. Study of various culture techniques used in plant tissue culture.
3. Recognition of the importance and applications of plant tissue culture.
4. Job oriented skill developments of students to start or work in commercial plant tissue culture laboratory

Course Outcomes: After completing this syllabus, students will be able to:

1. Use various in vitro culture techniques for plant / crop improvement.
2. Become an entrepreneur by developing his/her own Plant Tissue Culture lab.
3. Can enhance secondary metabolite content in different medicinal plants through in vitro culture techniques.
4. Have relevant knowledge and skill to establish and maintain green house for Hi Tech Agriculture/ Farming.

1.

Credits : 4	Core elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Introduction to Plant Tissue culture** Introduction to Plant Tissue culture, Terms and definitions, Historical background, Laboratory organization, Tools and techniques, methods of sterilization, basic techniques of plant tissue culture. Culture media, culture media preparation and sterilization, callus and suspension cultures.	15
II	**Organ Culture and Protoplast culture** Protoplast-Isolation regeneration and Viability test, Somatic hybridization and methods of protoplast fusion- chemical, Viral, electrofussion. Practical application of somatic hybridization and cybridization. Techniques and applications of somatic embryogenesis and regeneration of plants, anther, pollen, ovule, endosperm, hairy root cultures.	15
III	Somaclonal variation, its genetic basis and application in crop improvement. Cell/callus line selection for resistance to herbicide, stress and diseases. Role of tissue culture in rapid clonal propagation, production of pathogen - free plants and synthetic seeds.	15
IV	**Plant transformation:** Methods of gene transfer in plants. Agrobacterium and CaMV mediated gene transfer; direct gene transfer using PEG, micro injection, electroporation, microprojectile (biolistics) method, liposme mediated DNA delivery. Transgenic plants for crop improvement: Maize, Rice, Wheat, Cotton, Brinjal and Tomato.	15

Subject : **M.Sc. Botany 4th semester**	
Course Code : B041009T	Course Title : (c) **Microbial Biotechnology**

Course Objectives: The aim of this course is to enlighten the students about various microbes and their applications in industry as well to give a profound knowledge on fermentation technology, enzyme immobilization, etc.

Course Outcomes:

2. To understand the bioprocess engineering, basic techniques, methods, functions and industrial products.
3. To know about the different microorganisms and their products (enzymes, polymers, metabolites, etc.)
4. To learn about IPR (Patents, Copyrights, Trademarks, etc.) and its issues.
5. Conceptualize the basics of mutagenesis and its role in directed evolution of microbes.

Credits : 4	Core elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	Value addition in industrially important microorganisms using recombinant DNA technology. Fermentation technology; microbial growth, batch, fed batch and their continuous cultures of microbes, application of fermentation. Fermentation Economics.	15
II	Proteomics: Basic concept and importance. Metagenomics: types and applications. RNA Interference, Antisense RNA Technology, miRNA and Gene silencing. Mutagenesis (site-directed & random), directed evolution of microbes.	15
III	Industrial sources of enzymes; Cellulases, Xylanases, Pectinases, Amylases, Lipases, and Proteases, their production and applications. Immobilization of microbial enzymes and whole cells and their applications in industries. Microbial applications in food, feed and dairy. Synthetic Biology: A novel approach for Microbiology with example.	15
IV	Microbiology and up gradation of alcoholic beverages (i) C:H ratio balancing (ii) Trace elements (iii) RDT. Commercial production of important amino acids, insulin, steroids, vitamins and perfumes. Commercial production of antibiotics with special reference to penicillin, streptomycin and their derivatives. IPR (Patents, Copyrights, Trademarks) & its issues, WIPO (world intellectual property rights).	15

Suggested Readings:

Subject : **M.Sc. Botany 4th semester**	
Course Code : B041010T	Course Title : (d) **Herbal Products**

Objectives: To study preparation herbal medicinal product and herbal cosmetics

Course outcomes: Upon completion of the course, the students shall be able to understand following

1. Key ingredients used in herbal products and cosmetics
2. Key building blocks for various herbal formulations.
3. Various key ingredients and basic science to develop aromatherapy, cosmetics, cosmeceuticals.
4. Scientific knowledge to develop cosmetics and cosmeceuticals with desired Safety, stability, and efficacy.

Credits : 4	Core elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Herbs as raw materials:** Definition of herb, herbal medicine, herbal medicinal product, herbal drug preparation. Source of Herbs. Selection, identification and authentication of herbal materials. Processing of herbal raw material. Preparations of Decoction, Infusion, Fluid extract, Tincture, Aromatic water, Hair care Botanicals, Herbal Cream, Herbal Shampoo, Herbal Syrup	15
II	**Herbal Cosmetics:** Scope, Formulation development and quality control of Herbal cosmetics used in: Hair care, skin care, anti-wrinkles & anti-aging.	15
III	**Herbs in cosmetics:** A brief account of following herbals or herb extracts or herbal products of cosmetic importance such as *Acacia concinna* pods, *Aloe Vera*, Almond oil, Neem, *Citrus aurantium* peels, Henna, Turmeric, Liquorices, Olive oil, tea tree oil and wheat germ oil with special emphasis on their source, active principles and cosmetic properties.	15
IV	**Herbal formulations**: Conventional herbal formulations like syrups, mixtures and tablets and Novel dosage forms like phytosome. **Aromatherapy**: Various essentials oils used in Aromatherapy with their Significance. **Evaluation of Drugs**: WHO & ICH guidelines for the assessment of herbal drugs Stability testing of herbal drugs.	15

Suggested Readings:

1. Sharma, P. P. (2008). Cosmetics - Formulation, Manufacture and quality control, 4th edition, Vandana publication, Delhi.

Subject : **M.Sc. Botany 4th semester**	
Course Code: B041011P	Course Title : **Practical Lab 4**

Objective: To perform 20 experiments from the given list (at least 6 experiments from each units).

Course outcomes: Upon completion of the course, the students shall be able to learn followings-

1. Herbal preparations.
2. Pollen & pollen germination.
3. Ethnomedicinal plants & test related to Glycobiology

Credits : 4	Core compulsory
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):0-0-04

Unit	Topic	No. of Lectures (120 hrs)
I	1. Preparation and evaluation of gels like Shaving gels, Anti dandruff Shampoo and Hair styling gels. 2. Preparation of Mouth washes. 3. Preparation and evaluation of Cold Creams, Vanishing Creams. 4. Preparation of Hand and Body Lotions. 5. Preparation and evaluation of Face Masks. 6. Preparation of Hair oils to prevent hair fall. 7. Preparation and evaluation of *Aloe vera* Gel. 8. Preparation of Antiseptic cream (Turmeric). 9. Preparation and evaluation of Perfumes. 10. Preparation and evaluation of Herbal Henna. 11. Preparation of essential oils used in Aromatherapy.	40
II	1. Wodehouse technique and preparation of temporary pollen slides. 2. Acetolysis technique and Preparation of Permanent pollen slides. 3. Study of acetolysed pollen preparation of the following pollentypes- i). ***Hibiscus*** ii), ***Gossypium*** iii). ***Brassica*** iv), ***Eucalyptus*** v). ***Psidium*** vi), ***Sesamum*** vii). ***Citrus*** viii). ***Tridax***ix). ***Vernonia*** x). ***Boerhaavia*** xi). ***Cocos*** xii). ***Borassus.*** 4. Pollen production, pollen viability, pollen germination in vitro and pollen tube growth.	40
III	1. Plant tissue culture-based exercise. 2. Study of ethnobotanically important plant of your locality. 3. Simple chemical tests to detect biological glycans. 4. Extraction of exocellular polysaccharides (EPS) from yeasts/fungi. 5. Quantitative Extraction of starch from plant storage organs. 6. Extraction of soluble lectins from any one plant and fungal source.	40

Semester 4

Industrial Training/Research Project/Survey (Value Added)

Course Code: B041012 (Research Project)

Duration: 60 Hrs.

Course Objectives: The objective of this course is to provide students with hands-on training in specialized areas of plant sciences

Course Outcomes: After completion of this course the students will acquire the following:

1. Training in experimental design and execution
2. Knowledge on techniques and tools of research
3. Designing of research proposal.
4. Writing of research and review paper

Contents

The topic of the research project will be chosen from among the core compulsory courses/core elected courses of that year.

Course: M.Sc. (Chemistry)

Semester-wise titles of the Papers in M.Sc. (Chemistry)

Year	Sem	Course Code	Paper Title	Core Compulsory/ Elective/ Value added	Theory/Practical	Credits
1	I Sem	CH-1507	Inorganic Chemistry I	Core Compulsory	Theory	04
		CH-1508	Organic Chemistry I	Core Compulsory	Theory	04
		CH-1509	Physical Chemistry I	Core Compulsory	Theory	04
		CH-1510	Computer for Chemists	Core Compulsory &Ability Enhancement	Theory	04
		CO-6604	Chemistry in Life I	Minor open elective for other faculty	Theory	04
		CH-507	Inorganic Practical	Core Compulsory & Ability Enhancement	Practical	04
			Organic Practical	Core Compulsory & Ability Enhancement	Practical	
			Physical Practical	Core Compulsory & Ability Enhancement	Practical	
			Computer Practical	Core Compulsory & Ability Enhancement	Practical	
			Industrial Training/Project work/Literature survey	Core Compulsory		04
					Total credits	28
	II Sem	CH-2507	Inorganic Chemistry II	Core Compulsory	Theory	04
		CH-2508	Organic Chemistry II	Core Compulsory	Theory	04
		CH-2509	Physical Chemistry II	Core Compulsory	Theory	04
		CH-2510	Group Theory, Spectroscopy & Diffraction Methods & Solid State	Core Compulsory	Theory	04
		CO-7604	Open Elective (Chemistry in Life-II)	Minor open elective for other faculty	Theory	04
		CH-607	Inorganic Practical	Core Compulsory& Ability Enhancement	Practical	04

			Organic Practical	Core Compulsory& Ability Enhancement	Practical	
			Physical Practical	Core Compulsory& Ability Enhancement	Practical	
			Industrial Training/Project work/Literature survey	Core Compulsory		04
					Total credits	28
2	III Sem	CH-3507	Photochemistry	Core Compulsory	Theory	04
		CH-3508	Spectroscopy	Core Compulsory	Theory	04
		CH-3509	Analytical Chemistry	Core Compulsory	Theory	04
		CH-3510	Any one of the following: a) Bio-Inorganic Chemistry	Core Elective	Theory	04
		CH-3511	b) Bio-Organic Chemistry			
		CH-3512	c) Bio-Physical Chemistry			
		CH-707	Biochemistry Practical	Core Compulsory& Ability Enhancement	Practical	04
			Analytical Practical	Core Compulsory& Ability Enhancement	Practical	
			Industrial Training/Project work/Literature survey	Core Compulsory		04
					Total credits	24/ 28
	IV Sem	CH-4507	Environmental Chemistry	Core Compulsory	Theory	04
		CH-4508	Any three for Inorganic specialization: Inorganic Chemistry Special I	Core Elective	Theory	04 +
		CH-4509	Inorganic Chemistry Special II	Core Elective	Theory	
		CH-4510	Inorganic Chemistry Special III (Advanced Inorganic Chemistry)	Core Elective	Theory	04 +

		CH-4511	Inorganic Chemistry Special IV (Advanced Spectral Technique)	Core Elective	Theory	04
		CH-4512	Inorganic Chemistry Special V (Chemistry of Materials)	Core Elective	Theory	
		CH-4513	Any three for Organic specialization: Organic Chemistry Special I (Organic Synthesis)	Core Elective	Theory	04 +
		CH-4514	Organic Chemistry Special II (Medicinal Chemistry)	Core Elective	Theory	04
		CH-4515	Organic Chemistry Special III (Polymer Chemistry)	Core Elective	Theory	+ 04
		CH-4516	Organic Chemistry Special IV (Chemistry of Natural Products)	Core Elective	Theory	
		CH-4517	Organic Chemistry Special V (Heterocyclic Chemistry)	Core Elective	Theory	
		CH-4518	Any three for Physical specialization: Physical Chemistry Special I (Solid State Chemistry)	Core Elective	Theory	04 +
		CH-4519	Physical Chemistry Special II (Advanced Quantum Chemistry)	Core Elective	Theory	04
		CH-4520	Physical Chemistry Special III (Liquid State)	Core Elective	Theory	+
		CH-4521	Physical Chemistry Special IV (Physical Chemistry of Inorganic Reaction)	Core Elective	Theory	04

		CH-4522	Physical Chemistry Special V (Computational Chemistry)	Core Elective	Theory	
		CH-807	Practical	Core Compulsory& Ability Enhancement	Practical	04
			Industrial Training/Project work/Literature survey	Core Compulsory		04
			Total credits 24/28			

M.Sc. Chemistry
TWO-YEAR FULL-TIME PROGRAMME
(Four-Semester Course)

Subject Prerequisites

B.Sc. Degree (with Chemistry as one of the main subjects) with 45% marks in aggregate and 50% marks in the subject.

Programme Specific Outcomes (PSOs)

PSO 1: Students acquire a broad knowledge of descriptive Chemistry andmaster the basic analytical and technical abilities to work effectively in the various fields of chemistry.

PSO 2: Students develop critical thinking and analysis skills to solve complex chemicalproblems, e.g., analysis of data, synthetic logic, spectroscopy, structure andmodeling, team-based problem solving, etc.

PSO 3: They candetermine/evaluate the physical properties of chemicalreagents, predict outcomes of chemical reactions, and perform critical analysis of data.

PSO4: They can conduct experiments in the above sub-disciplineswith mastery of appropriate techniques and proficiency using core chemical instrumentation and modeling methods.

PSO5: They develop laboratory competence in relating chemical structure to spectroscopic phenomena.

PSO6: Students learn and understand the concepts of safe laboratory practices, safe disposal techniques, understand and comply with safety regulations, understand and use material safety data sheets (MSDS) and recognize and minimize potential chemical and physical hazards in the laboratory.

PSO 7: Project activity/industrial training/literature survey included in all the semester helps develop creative and innovative skills.

PSO 8:The students will have enough knowledge to serve industries, research institutions and academic organizations.

PSO 9: The students will be industry ready and can also become entrepreneurs.

Course Outcomes

SEMESTER I

- **CH-1507– Inorganic Chemistry I**
  To help them to learn the stereochemistry and bonding in main group compounds, metal ligand equilibrium in solution, reaction mechanism of transition metal complexes and metal-ligand bonding, electronic spectra and magnetic properties of transition metal complexes.

- **CH-1508 – Organic Chemistry I**
  To develop skills in the identification of aromaticity in organic molecules, stereochemistry, and reaction mechanism: structure and reactivity, aliphatic nucleophilic substitution and aliphatic electrophilic substitution.

- **CH-1509– Physical Chemistry I**
  To develop the knowledge about chemical thermodynamics, surface chemistry and electrochemistry.

- **CH-1510– Computers for chemist**
  To develop the skills in the area of knowledge of introduction to computers and computing, computer programming in FORTRAN/C/BASIC.

- **CH-507: PRACTICAL CHEMISTRY:**
  INORGANIC CHEMISTRY: Students gain expertise in gravimetric analysis, preparation of inorganic complexes and analysis of their properties.

  ORGANIC CHEMISTRY: Gain expertise on basic laboratory procedures involved in purification, identification and preparation of organic compounds.

  PHYSICAL CHEMISTRY: It helps them to learn the practical aspects of thermochemistry.

- **CO-6604: Chemistry in Life-1**

To develop the knowledge about general introduction of materials in daily life, pharmaceutical chemistry and in cosmetics and personal care products.

- Project activity/industrial training/literature survey included in the semester helps develop creative and innovative skills.

SEMESTER II -

- **CH-2507: Inorganic Chemistry II**
  To develop the knowledge about, metal pi complexes, metal clusters, nuclear chemistry and electronic spectroscopy.

- **CH-2508: Organic Chemistry II**
  To develop the knowledge about aromatic electrophilic substitution, aromatic nucleophilic substitution, free radical reactions, addition to carbon carbon multiple bonds, addition to carbon hetero multiple bonds, elimination reactions and pericyclic reactions.

- **CH-2509: Physical Chemistry II**
  To help them to learn advance quantum chemistry and thermodynamics.

- **CH-2510: Group Theory, Spectroscopy and diffraction method and Solid state**
  To develop the knowledge about symmetry and group theory in chemistry, unifying principles, vibrational spectroscopy, X-ray diffraction and magnetic resonance spectroscopy.

- **CH-607: PRACTICAL CHEMISTRY:**
  INORGANIC CHEMISTRY: Students gain knowledge in the practical field of acidimetric titrations, oxidation reduction titrations, estimate copper nickel in the given solution etc.

  ORGANIC CHEMISTRY: Students gain knowledge in the analysis of binary organic mixture and two step preparations.

  PHYSICAL CHEMISTRY: To develop practical skills in the determination of surface tension.

- **CO-7604: Chemistry in Life-2**

  To develop the knowledge about greenhouse effects, pesticides, cleansing agents and enzymes.

  - Project activity/industrial training/literature survey included in the semester helps develop creative and innovative skills.

SEMESTER III -

- **CH-3507: Photochemistry**
  To help the students gain knowledge in the field of photochemical reactions.

- **CH-3508: Spectroscopy**
  To develop the knowledge about inorganic spectroscopy and organic spectroscopy.

- **CH-3509: Analytical chemistry**
  To develop the knowledge about classification of analytical methods, errors and evaluation, radiochemical methods, thermal methods of analysis, chromatographic techniques, electro analytical techniques and atomic adsorption spectroscopy and flame photometry.

- **CH-3511: Bio-organic chemistry**
  To develop the knowledge about bioorganic compounds and chemistry

- **CH-707: Practical Biochemistry/ Analytical Chemistry**

  To gain the practical aspects of analysis of biochemistry and analytical techniques.

- Project activity/industrial training/literature survey included in the semester helps develop creative and innovative skills.

SEMESTER IV -

- **CH-4507: Environmental Chemistry**
  To develop the knowledge about environment, hydrosphere, soils, atmosphere, industrial pollution and environmental toxicology.

- **CH-4513: Organic Chemistry Special I (Organic Synthesis)**
  To develop the knowledge about organometallic reagents, oxidation, reduction, rearrangements and metallocenes, nonbenzenoid aromatic and polycyclic aromatic compounds.

- **CH-4514: Organic Chemistry Special II (Medicinal Chemistry)**
  To help the students to know about medicinal chemistry, drug design, combinatorial chemistry, computational approaches, biodisposition and implications, neuroactive agents, cardiovascular agents, antineoplastic agents and local anti-infective design.

- **CH-4515: Organic Chemistry Special IV (Polymer)**
  To help the students know about basics of polymer, characterization, structure and properties of polymer, polymer processing, and properties of commercial polymers.

- **CH-807:PRACTICAL CHEMISTRY**
  ORGANIC SYNTHESIS: To gain the practical aspects of analysis of ternary organic mixture, three step organic preparation, determine the strength of given aniline solution and determine the percentage of sulphur in the given organic compound.

- Project activity/industrial training/literature survey included in the semester helps develop creative and innovative skills.

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Chaudhary Charan Singh University, Meerut



Syllabus of:

M.Sc. (Physics)

(For fourth and fifth years of Higher education (PG))

(As per guidelines of U.P. Government according to National Education Policy-2020 w.e.f. the session 2022-2023)

(For both University Campus and Colleges)

M. Sc. PHYSICS (I SEMESTER): MATHEMATICAL METHODS IN PHYSICS

Course Objectives:

- To understand the various important mathematical methods in physics.
- To provide basic skills necessary for the application of mathematical methods in physics.
- To understand the mathematical methods in order to analyses theories, methods and interpretations.
- To develop understanding among the students how to use mathematical methods in their field of study of research and in the field of scientific knowledge to work independently

Course Outcomes:

- After completion of the course, students will have wide knowledge of Legendre, Hermite, Laguerre and Bessel polynomials, and their applications in physics and engineering.
- Students will be able to solve the research problems based on the complex variables, integral of complex functions,
- Students will earn the solution of various mathematical equations using Laplace transformation.
- Students will be able to use of Fourier series and transformation in some spectroscopic analysis.
- Students will understand the use of mathematical methods in their various branches of physics and engineering.
- The content given in 'Special functions and polynomials' of this course will impart skills for direct employability.

Unit 1. Special functions and polynomials: Graphical representation of basic mathematical functions.Solution of Legendre, Hermite and Laguerre differential equations. Generating function, Rodrigues's formula, recurrence relations, and orthogonality for Legendre, Hermite and Laguerre functions. Introduction of Associated Legendre polynomials. Solution of Bessel differential equation, Bessel functions of first kind. Generating function, recurrence relations and orthogonality for Bessel function. Expansion and integral of Bessel functions, Applications of special functions.

Unit 2. Complex Variables: Brief overview of complex numbers. Functions of a complex variable. Derivative and Cauchy Reimann equations. Analytic and harmonic function, Integration in the Complex plane, Line integrals of complex functions. Cauchy's integral theorem, Cauchy's Integral Formula. Laurent expansion, Classification of Singularities, Principal value of an integral. Cauchy's Residue theorem and evaluation of some typical real integrals using this theorem.

$\int_0^{2\pi} f(\sin\theta, \cos\theta)d\theta$, $\int_{-\infty}^{\infty} f(x)\,dx$, $\int_{-\infty}^{\infty} f(x)\,e^{iax}\,dx$

Unit 3. Laplace Transforms: Laplace Transform, Laplace transform of elementary Functions. First and second shifting theorems, Inverse Laplace transforms, Solutions of simple differential equations. Laplace transforms of derivative and integral of a function. Applications of Laplace Transform.

Unit 4. Fourier Series and Fourier Transform: Fourier series, Fourier series of even and odd functions. Half range expansion, Arbitrary period. Fourier integral and its complex form. Fourier transforms, Fourier sine and cosine transforms. Application of Fourier series and transformation.

Text and References Books

Mathematical method for Physics by G. Arfken
Advanced Engineering Mathematics by E. Kreyszig
Special Functions by E. D. Rainville
Special Functions by W.W. Bell
Complex Variables and Applications – Churchill
Mathematical Method for Physicists and Engineers by K.F.Reily, M.P.Hobson and S.J.Bence
Mathematical Physics by H.K. Das

M.Sc. PHYSICS (I SEMESTER): CLASSICAL MECHANICS

Course Objectives:

The primary objectives of classical mechanics course are:

- To study the mechanics of dynamical systems using Lagrange's equations of motion for conservative and non-conservative systems through Lagrangian formulation.
- To study variational principle and solve basic problems using calculus of variations.
- To understand the problem of two bodies moving under the influence of a mutual central force motion of the Lagrangian formulation.
- To understand the theory of small oscillations applied in many physical applications with the concept of stable and unstable equilibrium.
- To study and understand the Hamiltonian formulation for solving of mechanical problems using Hamilton's equations of motion.

Course Outcomes:

On the successful completion of classical mechanics, the students will able to learn and understand the fundamental concepts of dynamics of system of particles, related conservation theorems, equations of motion for mechanical systems using the Lagrangian and Hamiltonian formulation. The main course outcomes are as follows:

- Able to solve the mechanics of dynamical systems using Lagrange's equations of motion for conservative and non-conservative systems through Lagrangian formulation.
- Able to understand the variational principle and its application to solve mechanical problems using Lagrangian formulation.
- Able to deal with the problem of two bodies moving under the influence of a mutual central force motion.
- Able to understand the theory of small oscillations applied in many physical applications.
- Able to solve mechanical problems using Hamilton's equations of motion by Hamiltonian formulation.

Unit 1. Review of Elementary Principles and Lagrange's Equations of Motion: Overview of mechanics of a particle and system of particles, Types of Constraints on dynamical systems with suitable examples,Conservation theorems, D'Alembert's principle, generalized coordinates and generalized force, Derivation of Lagrange's equations, Velocity-Dependent potentials and the Dissipation function, Applications of Lagrangian formulation: single particle in space, Simple pendulum with rigid support, Atwood's machine, Time-dependent constraint-bead sliding on rotating wire.

Unit 2. Variational Principles and Lagrange's Equations: Hamilton's principle, Some techniques of the calculus of variations: Shortest distance between two points in a plane, Minimum surface of revolution and The brachistochrone problem, Derivation of Lagrange's

equation from Hamilton's principle, advantages of variational principle formulation, Canonical or Conjugate momentum, Cyclic coordinates and conservation of conjugate momentum.

Unit 3. Two Body Central Force Problem and Small Oscillations: Reduction to the equivalent one-body problem, Equations of motion and first integrals, Equivalent one-dimensional problem and classifications of orbits, Virial theorem, The inverse square law of force, Kepler problem, Concept of small oscillations: stable and unstable equilibrium, Formulation of the problem: Expression of kinetic energy and potential energy for small oscillations.

Unit 4. Hamiltonian equations of motion: Legendre transformations and Hamilton equations of motion, Representation of Hamilton's equations of motion in matrix notation, Cyclic coordinates and conservation theorems, Derivation of Hamilton's equations from a variational principle, Principle of least action, Equations of canonical transformation, generating functions, Poisson brackets and canonical invariants, Relation of Poisson brackets, Hamilton-Jacobi Theory: Hamilton-Jacobi equation for Hamilton's principal function.

Text and Reference Books

Herbert Goldstein, Charles P. Poole, John Safko: Classical Mechanics
N.C. Rana and P.S. Joag : Classical Mechanics
A. Sommerfiel : Mechanics
Perceival and D. Richards: Introdution to Dynamics

M.Sc. PHYSICS (I SEMESTER): QUANTUM MECHANICS

Course Objectives:

The primary objectives are:

- To study time-independent and time-dependent Schrodinger wave approach.
- To solve a one-dimensional Schrodinger equation for simple problems.
- To develop theory of angular momenta and addition of angular momenta
- To understand the applicability of angular momenta in several branches of physics
- To understand the applicability of angular momenta in several branches of physics

Course Outcomes:

After completing this course, students will be able to

- To understand the physical and mathematical basis of quantum mechanics for non-relativistic systems.
- To learn mathematical tools needed to develop the formal theory of quantum mechanics.
- To understand the measurement process in quantum mechanics.
- Understand the connection between measurement of results and the uncertainty relation.
- Understand the application of wave function theory in quantum mechanics.
- Appreciate the amazing power and surprises of quantum mechanics in problems like free particle and particle in a potential.
- Recognize the applicability of angular momenta in several branches of physics.
- Appreciate the profound strength of approximate methods in problems like Stark effect, Zeeman effect, etc.
- Understand the scattering processes that take place in atomic, subatomic, and molecular systems.

Unit 1. Fundamental Concepts:
Wave packets,Commutator algebra and uncertainty relation,Motion of wave packets, Wave functions in position and momentum space. Operators, Hermitian operators,Degeneracy, Orthonormality and Completeness. Linear operators, Dirac notation,Matrix representations, Change ofbasis, Three dimensional potential well and Hydrogen atom, vector and Hilbert Spaces, Bases, Dimension, Subspaces, Dual spaces, Inner product of spaces, Dirac notations, matrix representation of operators,Linear harmonic oscillator in matrix formulation, Rotation generators, Transformations of dynamical variables, Symmetry and conservation laws. Symmetric and anti-symmetric wave-functions and Pauli Exclusion Principle.

Unit 2. Quantum Dynamicsand Approximate Methods: Time independent first and second order perturbation theory for non-degenerate and degenerate levels, Variational method, and its application for Helium atom, WKB Approximation. Application of electric field (Stark effect), Dipole Polarizability of ground state Hydrogen atom, normal and anomalous Zeeman Effect.

Unit 3. Theory of Angular momentum: Commutation relations involving angular momentum operators, the eigenvalue spectrum, Matrix representation of J , Addition of angular momentum, Clebsch- Gordon coefficients, Spin angular momentum, Spin wave functions, Addition of spin and orbital angular momentum.

Unit 4. Scattering Theory: Laboratory and centre-of-mass systems, scattering by potential field, scattering amplitude, differential and total cross sections, phase shift, Lippmann-Schwinger equation, and First Born approximation.

Text and References Books

R. Shankar, Principles of Quantum Mechanics, Second Edition, Springer.
E. Merzbacher, Quantum Mechanics, Third Edition, Wiley.
Quantum Mechanics by S. Gasiorowicz.
Quantum Mechanics by Zettlei
A text book of Quantum Mechanics by P.M. Mathews and K. Venkatesan
Introduction to Quantum Mechanics by E. Merzbacher
Quantum Mechanics by L.I. Schiff
Quantum Mechanics by I. S. Tyagi

M.Sc. PHYSICS (I SEMESTER): ELECTRONIC DEVICES

Course Objectives:

The primary objectives are:

- To study the transport mechanism of elemental and compound Semiconductors.
- To study the effect of dopant concentration and temperature on devices performance.
- To studythe junction characteristics of pn- and metal-semiconductor diodes.
- To learn and understand the FET transfer characteristics.
- To learn and understand the role of metal oxide layer in MOSFETs.
- To study the basic role of an amplifiers in modern devices.

Course Outcomes:

- To understand the conduction mechanism of elemental and compound semiconductors for designing the electronic components and circuits.
- Understanding the basic phenomenon of semiconductors, it can be used for the fabrication of modern devices.
- Having the knowledge of semiconductors, junction diodes, diode and transistor biasing, and amplifies, students can have the job in semiconductor and microelectronic Industries, communication and telecommunication government and private sectors.

Unit 1. Conduction Mechanism in Semiconductors

Basic carrier transport mechanisms in semiconductors;Direct and indirect bandgap,Electron and hole concentrations in bands for degenerate and nondegerate states, Elemental and compound, Amorphous and crystalline phase in Semiconductors; Carrier concentrations, Conductivity, mobility in Semiconductors; Fermi Level, electron and hole concentrations at equilibrium;Temperature dependence of carrier concentrations, drift and diffusion of charge carriers; Effect of dopant concentration and temperature on the mobility, The continuity equation.

Unit 2. P-N junction & Metal-semiconductor diode

Qualitative theory of P-N junction, Space charge at a junction, Capacitance of p-n junctions;Generation and recombinationcharge carriers, Diffusion capacitance; Breakdown mechanisms: Thermal instability, Tunneling andavalanche multiplication;Transient and noise behavior, device performance as the rectifier, voltage regulator; Device structure and energy band diagram, Schottky effect, Barrier height; Voltage dependence of semiconductor surface potential, Current transport mechanisms, Device capacitance, Ohmic contact.

Unit 3. Field Effect Transistors

JFETs: Drain, source and Gate, Transfer characteristics,Current equations, Pinch off voltage and its significance; The FET small signal model, Measurement of g_m and r_d, JFET fixed bias, Self-bias and voltage divider configurations, JFET source follower (common-Drain) configuration; JFET Common Gate configuration;MOSFET- Characteristics, Threshold voltage, Channel length modulation, D-MOSFET, E-MOSFETCharacteristics, Comparison of MOSFET with JFET; Depletion and enhancement type MOSFETs.

Unit 4. Feedback Amplifiers: The transistor as an Amplifier, Analysis of a Transistor amplifier circuit using h parameters, Hybrid π model, Ebers-Moll model, Transistor biasing and thermal stabilization;Classification of Amplifiers, Feedback concept, Ways to introduce negative

feedback in Amplifiers, Effect of negative feedback, Method of analysis of a feedback amplifier, Volatge-series feedback, Current-series feedback, Volatge-shunt feedback, Current-shunt feedback, Nyquist criterion for stability of feedback amplifiers.

Text and Reference Books

Physics of Semiconductor Devices by S.M. Sze&Kwok K. Ng
Solid State Electronic Devices by B.G. Streetman
Electronic Devices and Circuit Theory by R.L. Boylested and L. Nashelsky
Integrated Electronics by J. Millman and C.C. Halkias
Introduction to Semiconductor Devices by M. S. Tyagi
Electronic Devices and Circuits by Balbir Kumar and S.B. Jain

M.Sc. PHYSICS (II SEMESTER): ADVANCED QUANTUM MECHANICS

Course Objectives:

- To teach the students various approximation methods in quantum mechanics.
- To teach Klein-Gordon and Dirac approaches to under Relativistic quantum theory
- To teach the importance of quantization of electromagnetic radiation in science
- To make the students understanding about introductory quantum field theory.

Course Outcome:

After completing this course, students will be able to

- Understand the time-dependent Schrodinger wave approach and its applications in real life
- Understand the importance of second quantization connection between symmetries, degeneracies, and conservation laws.
- Understand the importance of second quantization
- Differentiate between classical and quantum identical particles.
- Get basic information needed for advanced courses like quantum field theory.
- The course contents like quantum transitions process for solid-state and gas lasers, the process of second quantization and part of field theory are directly useful for employment.

Unit 1. Approximation Methods(Time Evolution): First order perturbation, Interaction of an atom with an electromagnetic field, Transition probabilities, Fermi Golden rule, Dipole approximation.Einstein's coefficients based on quantum mechanics, Induced and spontaneous emissions of radiations,Applications of transition quantum theory in gas and solid state lasers, adiabatic approximation.

Unit 2. Quantum Theory of Radiation: Classical radiation field, Fourier decomposition and electromagnetic radiation field, dipole approximation, Second Quantization, Creation, annihilation and number operators, Photon states, Basic matrix elements for emission and absorption, explanation of stimulated and Spontaneous emission on the bases of quantum mechanics, Importance of second quantization, Plank's radiation law.

Unit 3. Relativistic Quantum Theory: Klein-Gordon equation and its plane wave solution, Probability density in KG theory, Difficulties in KG equation, Dirac equation for a free electron, Dirac matrices and spinors, Plane wave solutions, Charge and current densities, Existence of spin and magnetic moment from Dirac equation of electron in an electromagnetic field. Dirac equation for central field with spin orbit interaction, Energy levels of Hydrogen atom from the solution of Dirac equation, covariant form of Dirac equation.

Unit:4 Introduction of Quantum Field theory:

Lagrangian density and equation of motion for field, Symmetries and conservation laws, Noether's theorem, canonical quantization of scalar field, Complex scalar field, electromagnetic field and Dirac field, Problem in quantizing electromagnetic field, Gupta & Bleuler method.

Text and Reference Books

Quantum Mechanics and Atomic Physics by S.P. Khare.
Quantum Mechanics by L.I. Schiff

Modern Quantum Mechanics by J.J. Sakurai
A Text Book of Quantum Mechanics by P.M. Mathews and K.Venkatesan
Quantum Mechanics by A. P. Messiah
Relativistic Quantum Mechanics: J.D. Bjorken and S.D. Drell.
Relativistic Quantum Fields: J.D. Bjorken and S.D. Drell.
A First Book on Quantum Field Theory: Amitabha Lahiri and P.B. Pal
Modern Quantum Mechanics: J.J.Sakurai.
Principles of Quantum Mechanic: R. Shankar.

M.Sc. PHYSICS (II SEMESTER): STATISTICAL MECHANICS

Course Objectives:

- To understand the analysis of the statistical macroscopic quantities of various systems in terms of constituents.
- To learn the ensemble theory and their macroscopic parameters.

- The application of Bose Einstein statistics and Fermi-Dirac statistics to analysis the properties of ideal Bose gas and Fermi-Dirac gas.
- To understand the various models of cluster expansion and fluctuations of thermodynamic variables.
- To learn the theoretical aspect of order-disorder phase transition in various systems.

Course Outcomes:

- After completion of the course, the students will have the basic knowledge of statistical mechanics.
- Students will be able to calculate the statistical quantities of various systems.
- Students will be able to eexplain the ensemble theory required for macroscopic properties of the matter in bulk in terms of its constituents.
- Students will understand the analysis of properties of ideal Bose gas, Bose- Einstein condensation, liquid helium and electron gas.
- Students will be able to understand the various theories and models of cluster expansion and fluctuations of thermodynamic variables.
- Students will have the knowledge to explain the theoretical aspect of order-disorder phase transition in various systems.

Unit 1. Ensembles and Statistics of Ideal Gas System. Scope and objective of statistical mechanics. Analysis of phase space, phase points, Mu and Gamma space, Ensemble. Density of phase points,Microstates and Macrostates, Number of accessible microstates.Detailed analysis of micro canonical, canonical and grand canonical ensembles and their properties. Partition function formulation. Fluctuation in energy and particle. Equilibrium properties of ideal systems: classical ideal gas, Harmonic oscillators, Para magnetism, concept of negative temperature. The entropy of mixing of ideal gas and Gibbs paradox, Sackur-Tetrode equation.

Unit 2. Quantum Statistical Mechanics: Transition from classical statistical mechanics to quantum statistical mechanics. Postulates of quantum statistical mechanics, Density matrix, Indistinguishability and quantum statistics, identical particles and symmetry requirements. Basic postulate and particle distribution function of Bose Einstein statistics. Energy, number of particles and pressure of B.E. gas. Bose Einstein Condensation, Thermal properties of B.E. gas, Transition in liquid He_4, Superfluidity in He_4. Basic postulate and particle distribution function of Fermi Dirac statistics. Energy, number of particles, temperature and pressure of F.D. gas. Properties of ideal electron gas, Thermionic Emission.

Unit 3. Statistical models for order-disorder phase transition: Cluster expansion for a classical gas, virial equation of state, ising model, mean-field and Heigenburg theories of Ising model, Exact solutions in one-dimension. Thermodynamic phase diagrams, Order parameter, Landau theory of phase transition, Landau theory of liquid He-II, critical exponents, Scale invariance, Critical dimensionality.

Unit 4. Fluctuations: Introduction to non-equilibrium processes, fluctuations and transport phenomena, Random walk and Brownian motion, Langevin theory of Brownian motion and relation with diffusion equation, The Fokker-Plank equation.

Text and Reference Books

Statistical and Thermal Physics by F. Reif
Statistical Mechanics by K. Huang
Statistical Mechanics by R. K. Pathria
Statistical Mechanics by R. Kubo
Statistical Physics by Landau and Lifshitz
Statistical Mechanics and properties of matter, theory and application by E.S.R. Gopal

M.Sc. PHYSICS (II SEMESTER): ATOMIC AND MOLECULAR PHYSICS

Course Objective

The study of atoms and molecules has played a major role in the development of physics and in the development of our understanding of the structures and properties of matter as it is encountered in everyday life. The main objectives of this course are

- To develop an understanding of the atomic emission/ absorption spectra of one electron and many electrons atoms.
- To understand the concept of molecular spectroscopy of diatomic molecules which includes Rotational, Vibrational and Electronic energy levels.
- To gain insight of important characterization techniques such as IR/FTIR, Raman, PES, NMR, ESR etc.

Learning outcomes:

On successful completion of this course, the student will:

- Develop the ability to conceptually understand the atomic spectra of Hydrogen atom and similar a valance electron atoms.
- Be able to understand and interpret the atomic spectra for many electron atoms.
- Also can also explain the change in behavior of atoms in external applied electric and magnetic field and corresponding changes in observed spectra.
- Gain sufficient understanding of rotational, vibrational, electronic and Raman spectra of molecules.
- Develop skill in important material characterization techniques like IR/FTIR, Raman, etc.
- Acquire ability to apply Nuclear Magnetic Resonance (NMR) for structure elucidation of synthesized materials.

Atomic Physics:

Unit 1. Introduction to Atomic spectra, Quantum states of an electron in Hydrogen atom.Relativistic corrections for energy levels of hydrogen atom.Concept of spin and fine structure of hydrogen atom. Singlet and triplet States of Helium.Broad features of spectra of alkali elements. Fine structure in Alkali Spectra.

Unit 2. Many electron atoms: Central field approximation, Atomic wave function, Hartree and Hartree–Fock approximations, Results of Hartree's theory, Spectroscopic Terms: LS coupling, Lande Interval rule, determination of spectral terms for atoms; with two or more Non-equivalent optical electrons, and two or more equivalent optical electrons. Breit's scheme. JJ coupling for many electron atoms.Atom in external field, Zeeman, Paschen-Bach & Stark effects.

Molecular Physics:

Unit 3. Born-Oppenheimer approximation,Classification of Molecules, Types of Molecular Spectra and Molecular Energy States: Pure Rotational Spectra, Vibrational-Rotational Spectra, Raman Scattering, Classical and Quantum theory of Raman effect. Selection rules, Isotope effect, Formation of electronic spectra, fine structure of electronic bands. Intensity distribution in electronic bands: Franck-Condon principle. Explanation of intensity distribution in absorption and emission bands from Franck-Condon principle.

Characterization Techniques:

Unit 4. Infrared/FTIR Spectroscopy, General description and working of dispersive and FTIR instrument. Interpretation of FTIR spectra. Raman spectroscopy. Nuclear Magnetic Resonance, Chemical Shift, NMR Spectrometer. NMR spectrum analysis.

Text and Reference Books

Introduction to atomic spectra by H.E. White
Spectra of diatomic molecules by Herzberg
Atoms and molecules by M. Weissbluth
Quantum theory of Atomic Structure Vol I by Slater
Quantum theory of molecules and Solids by Slater
Fundamentals of molecular spectroscopy by C.B.Banwell
Introduction to molecular spectroscopy by G.M.Barrow
Molecular spectroscopy by J.M.Brown
Infrared and Raman spectroscopy: Principles and spectral Interpretation by Peter J. Larkin
Lasers: Fundamentals and Applications by Ajoy Ghatak and K. Thyagarajan

M.Sc. PHYSICS (II SEMESTER): ELECTRODYNAMICS & PLASMA PHYSICS

Course Objectives:

- To teach the students about the basic phenomenon of electrostatics and magnetostatics for the application of electromagnetism.

- To study the transfer of energy in terms of electro-magnetic waves.
- To learn about the formation of plane electromagnetic waves for transmitting and receiving data in terms of photons.
- To learn about the work-energy theorem for data transfer mechanism.
- To study the fundamental of Plasma and used in communication.

Course Outcome:

After completing this course, students will

- Understand the electromagnetic phenomenon used for the wireless communication in terms of photons.
- Understand the importance of reflection, transmission, and absorption of electromagnetic waves.
- Understand the importance of work-energy phenomenon used for transmission of data by using plane electromagnetic waves.
- Studying this syllabus, the students can get a chance to utilize their skills in wireless and telecom industries for propagation/receiving signal/data/energy.

Unit 1. Electrostatics

Physical significance of Vector algebra and Calculus: divergence, gradient, and Curl; Electrostatic fields in matter, Dielectrics, Polarization; Field inside a dielectric, Electric displacement, Linear dielectrics;Gauss's divergence theorem and symmetry: planner (pillbox), co-axial (cylindrical), spherical (concentric); Laplace's and Poisson Equations, Methods of images, point charge near an infinite conducting plane, Point charge in the presence of grounded conducting sphere, Point charge in presence of charged insulated sphere.

Unit 2. Magnetostatics

Magnetic vector potential, Magnetostatic fields in Matter: Magnetization, Ampere's circuital law; field of a magnetized object, magnetic field inside matter, linear and nonlinear magnetic media.

Unit 3. Plane Electromagnetic Wave

Basic phenomenon of electromagnetic waves: Reflection, Refraction at an interface between dielectrics, transmission, absorption; Plane electromagnetic waves in free space, dielectrics and conducting media; Fresnel's relation of polarization by reflection and total internal reflection; Maxwell's displacement current, Maxwell's equations, Maxwell's equations in terms of vector and scalar potentials, Poynting theorem, Lienard- Wiechert potentials due to a point charge, Fields of a point charge in motion, Power radiated by an accelerated charge, Larmor's formula and its relativistic generalization.

Unit 4. Plasma

Definition of plasma, Concept of temperature, Debye shielding, Criteria for plasma, Single-particle motions in E and B fields, Magnetic mirrors and plasma confinement, Plasma as fluid, the fluid equation of motion, Equation of continuity and equation of state, Waves in plasmas, Plasma oscillations, Plasma frequency ωp, Electron plasma waves, ion waves, Electron and ion oscillations perpendicular to B and parallel to B, Cutoffs and resonances.

Text and Reference Books;

Classical Electrodynamics by J.D. Jackson
Foundations of Electromagnetic theory by J.R. Reitz, F.J.Milford and R.W.Christy
Introduction to Electromagnetics by David J. Griffiths
Introduction to Plasma Physics and Controlled Fusion, Vol-1: Plasma Physics by Francis F. Chen
Plasma Physics by S.N. Sen.)

M.Sc. PHYSICS (III SEMESTER): CONDENSED MATTER PHYSICS

Course Objective

To study some of the basic properties of the condensed phase of matter especially solids. Condensed matter Physics is the study of the structure and behavior of the matter that makes up most of the usual stuff that surrounds us every day. Condensed Matter Physics is the fundamental

science of solids and liquids. It has the greatest impact on our daily lives by providing foundations for technology developments.

Learning outcomes:

After completing this course, students will

- Be able to correlate real and virtual lattice which is the key of structure property relationship of any solid.
- Develop skill in X-ray diffraction techniques and its applications.
- Gain knowledge of various crystal imperfections and their impact of properties of the material.
- Also be able to explain electronic and magnetic properties. The knowledge may help them to design new materials with desired electronic and magnetic properties.
- Learn about the basic concept of super conductivity and its application in various fields.

Unit 1. Bravais lattice, primitive vectors, primitive unit cell, conventional unit cell, Wigner-Seitz cell; Sym- metry operations and classification of 2- and 3-dimensional Bravais lattices; point group and spacegroup (information only); Common crystal structures: NaCl and CsCl structure, close-packed structure, Zinc blende and Wurtzite structure, tetrahedral and octahedral interstitial sites, Spinel structure.
X-ray diffraction, The Laue, powder and rotating crystal methods, Reciprocal lattice and Brillouin zone; Ewald construction; Explanation ofexperimental methods on the basis of Ewald construction.Anomalous scattering; Atomic and geometric structure factors; systematic absences.Point defects (Schottky & Frankel Defects) Imperfections, Line defects (Edge& Screw dislocations), Burger vector & Burger Circuit Planer (stacking) faults.

Unit 2. Different types of bonding in solids, covalent, metallic, Vander Waal, hydrogen bonding & ionic bonding, Madelung constant of ionic crystals, cohesive energy. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Drude model of electrical and thermal conductivity. Hall effect and thermoelectric power.

Unit 3. Electronics Properties of Solids: Electrons in a periodic lattice: Bloch theorem, The Kronig-Penny Model, Effective mass of an electron, Tight-binding approximation, Cellular and pseudopotential methods.
Superconductivity: Review of basic properties, Meissner effect, Type-I and Type-II superconductors, thermodynamics of superconductors, London's phenomenological theory, Flux quantization. Elements of BCS theory. Josephson junction and applications.

Unit 4.Magnetic Properties of Solids: Weiss theory of ferromagnetism, Heisenberg model and molecular field theory, Ferromagnetic domains, The Bloch-wall, Spin waves and Magnons, Curie- Weiss law for susceptibility, Ferri and antiferro-magnetic order.

Text and References Books

Verma and Srivastava: Crystallography for SolidState Physics

Azaroff: Introduction to Solids
Solid State Physics by S O Pillai
Omar: Elementary Solid State Physics
Aschroff & Mermin: SolidState Physics
Kittel: SolidState Physics
Chaikin and Lubensky: Principles of Condensed Matter Physics

M. Sc. PHYSICS (III SEMESTER): OPERATIONAL AMPLIFIER AND DIGITAL CIRCUITS

Objectives:

- To learn about the basic and advanced knowledge of amplifier, operational amplifiers.
- To study voltage and current controlled Source, rectifiers, and gains.

- To study the CMOS technology and logic families.
- To study the digital numbers system, logic gates for mathematical operations and memories.
- To design the arithmetic logic circuits and storage data systems: flip-flop, registers. Counters and converters.

Learning outcomes:

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

- To learn for designing of amplifiers, operational amplifiers for various applications.
- To learn for CMOS technology, ICs designing for digital circuit operations.
- Having the knowledge of number systems and logic gates, students can develop the mathematical operations.
- To learn the actual role of Transistors for making ICs and data storage systems.
- After studied and practical learning of logic families, gates, and circuits, the students can get the job in microelectronic component industries, telecommunication industries for designing circuits and their functions.

Unit I: Operational Amplifier and their Application

Characteristics of an ideal operational amplifier, Op-Amp Specifications, DC Off-set parameter, Frequency parameters, Applications of operational amplifiers: Inverting and Non-inverting amplifiers, Unity follower, Voltage summing and subtraction, Integrator, Differentiator, multiple stage gain, Current controlled voltage source, Voltage controlled current source, Rectifiers and Limiters, Comparators and Schmitt Triggers, Active filters.

Unit II: Logic Families

Logic gate symbols and truth tables, Classes of digital integrated circuits (Diode logic, DTL, TTL, ECL, MOSFET, CMOS), Transistor- Transistor Logic (TTL), Single Input TTL Inverter (transfer characteristic), Multi- collector transistors, Propagation delays, Diode Logic, DTL NAND Gate (transfer characteristic, noise immunity, fan out), Emitter Coupled Logic (transfer characteristic of OR/NOR gate, practical implementation, MOSFET Logic, MOSFET Inverter, MOSFET NOR and NAND gates, Complementary MOS (CMOS)- CMOS inverter, CMOS NOR and NAND, Power dissipation in CMOS, Advantages/Disadvantages of CMOS.

Unit 3: Digital Electronics and Logic Gate

Number systems: Binary, Octal, Decimal and Hexadecimal, Base conversion systems, Basic logic gates: OR, AND and NOT, Bubbled gate, Boolean Algebra, De-Morgan's theorems, Boolean equations of Logic circuits, Combinational logic circuits, NOR and NAND Gates, Sum of Product (SOP) and Product of Sum (POS) methods, Karnaugh map (K-map), pairs, quads and octets, K-map simplifications, Don't care conditions, Product of Sum simplifications,Min-terms and Max-terms, Converting a truth table to an Equations, Exclusive-OR gate, BCD to decimal decoders, Excess-3 code, Gray code,.

Unit 4: Application of Digital Logic Gates

Arithmetic circuits: binary addition and subtraction, 1's and 2's complement arithmetic and representation; Arithmetic building blocks, Half adder and Full adder circuits; Multiplexers and

Demultiplexer, RS Flip-Flops: NOR and NAND gate latch, Clocked RF Flip-Flops, Edge-triggered D Flip-Flop, T-Flip Flop, JK Flip-Flop, Flip-Flop timing, JK Master-Slave Flip-Flops; Registers, Types of registers, Serial-in-serial out, Serial-in-parallel out, Parallel-in-serial out, Parallel-in parallel out; Counters: Asynchronous and synchronous counters, Mod-3 and Mod-5 counters, Shift counters; Digital-to-Analog and Analog-to-Digital Converters; Microprocessor-8085 microprocessor architecture, interfacing devices, BUS timing, Basic terms and ideas of memory.

Text and Reference Books

Electronic Device and Circuit: R. Boylested and L. Nashdsky
Analysis and Design of Digital Integrated Circuit: Hodges, Jackson and Saleh
Digital Principles and Implementation: A.P. Malvino and D.P. Leach
Op- Amp and Linear Integrated Circuit: Ramakant A. Gayakwad
Linear Integrated Circuit: Choudhary and Jain
Digital Principals and Applications: D.P. Leach & A.P. Malvino

M. Sc. PHYSICS (III SEMESTER): ELECTRONIC COMMUNICATION SYSTEMS

Course Objective

The fundamental objectives of this course are;

- To enable students to understand the basic concepts of circuits found in radio-communication.
- To interpret and analyze the characteristics of the main components of communication electronics.
- To impart in depth knowledge of different types of analog communication systems and different modulation techniques used in these systems.
- To be able to design the simplest devices and transmitting and receiving systems of radiofrequency series.
- To introduce the various types of transmission lines and to discuss the losses associated.
- To give thorough understanding about impedance transformation and matching.

Course Outcomes:

On completion, the student will be able to;

- Analyze analog communication signals in time domain and frequency domain.
- Distinguish between different analog modulation techniques.
- Analog signal generation techniques.
- Discuss the fundamental concepts of wave propagation in Transmission Lines.
- Analyze the line parameters and various losses in transmission lines.
- Apply smith chart for line parameter and impedance calculations

Unit 1. Amplitude Modulation Systems: Principles of Amplitude Modulation; AM envelope and Equation of AM wave, Modulation index and Percent Modulation, Frequency Spectrum and Bandwidth, AM Power Distribution, AM by Multiple Sine waves, Transmission efficiency, Double Side-Band Suppressed Carrier (DSB-SC), AM Modulator Circuits; Low-level AM Modulator, Medium Power AM Modulator

Unit 2. Single- Sideband Techniques: Evolution and Description of Single Sideband Modulation (SSB); Suppression of Carrier, Balanced Modulator, Suppression of Unwanted Sideband, The filter. System, The phase-shift method, System evaluation and comparison, Extensions of SSB, Vestigial-sideband Modulation

Unit 3. Frequency Modulation Systems: Theory of Frequency and Phase Modulation, Relationship between phase and frequency modulation, Mathematical Representation of FM, Phase and frequency deviation, Spectrum of an FM signal, Sinusoidal modulation, Bandwidth of a sinusoidally modulated FM signal, Generation of FM signal, Direct and Indirect Methods

Unit 4. Transmission Line Theory & Optical Fiber Communication Systems: Fundamental of Transmission lines, Different types of Transmission lines, Primary line constants, phase velocity and line wavelength, Characteristic impedance, Propagation Coefficient, Phase and group velocities, Standing waves, Lossless line at radio frequencies, Voltage standing wave ratio, Slotted line measurements at radio frequencies, Transmission lines as circuit elements, Drawbacks of Radio communication, Introduction to Optical Communication, Fiber index profiles, Modes of Propagation, Number of Propagated modes in Step-index Fibers, Losses in Fibers.

Text and Reference Books

Modern Electronic Communication by Gary M. Miller, 6th edition
Electronic Communication Systems by George Kennedy and Bernard Davis, 4th edition Principles of Communication Systems by H. Taub and Donald L. Schilling
Electronic communications by Dennis Roddy and John Coolen
Electronic Communication Systems-Fundamentals through Advanced by Wayne Tomasi, 4th edition

M. Sc. PHYSICS (III SEMESTER): NUCLEAR AND PARTICLE PHYSICS

Course Objectives:

- To impart knowledge about nuclear properties.
- To understand the nuclear decay, inter-nucleon forces and related facts.
- To understand the Nuclear reactions.

- To understand the different nuclear detectors.
- To understand the different nuclear modals to know fundamental principles and concepts governing nuclear structures.
- To understand the particle physics to construct nuclear reactions.

Course Outcomes:

- After completion of the course, students will learn about the nuclear angular momentum and dipole moment of nuclei.
- They will understand the concept of inter nucleon forces and related facts.
- Students will understand the parity violation in beta-decay.
- Students will understand nuclear reactions and detectors.
- Students will obtain the knowledge ofthe nuclear structure and various important nuclearmodels.
- They will be able to construct nuclear reactions using the conservation laws for elementary particles.
- The knowledge of various detectors will impart skills for direct employability.

Unit 1. Nuclear Structure andNuclear force: Nuclear structure and properties. Binding energy per nucleon, Proton and neutron separation energy. Analysis of nuclear angular momentum, nuclear magnetic dipole moment and nuclear electric quadruple moment, Parity quantum number. Overview of Deuteron properties. Theory of Deuteron ground state and excited states. Two-nucleon scattering at low energy, neutron-proton scattering, partial wave analysis, phase-shift, scattering length, proton- proton scattering (qualitative discussion). Charge symmetry and charge independence of nuclear forces, exchange nature of nuclear forces, saturation of nuclear forces.

Unit 2. Nuclear Models: Fermi gas model, Experimental evidence for shell structure in nuclei, Basic postulates of shell model, Single- particle energy levels in central potential, Spin-orbit potential and prediction of magic numbers, Extreme single- particle model, Prediction of angular momenta, Parities and magnetic moment of nuclear ground states, Semi- empirical mass formula, The unified model.

Unit 3. **Nuclear Decay, Reactions and Nuclear detectors:** Overview of alpha, beta and gamma-decay, Parity violation in beta decay, Neutrino, Wu's experiment in beta decay, Internal conversion. Introduction and types of nuclear reactions, conserved quantities of nuclear reaction, energies of nuclear reaction, Q value, exoergic & endoergic reactions, nuclear fusion and fission reactions. Interaction of radiation with matter, Ge and Si solid state detectors. Calorimeters and their use for measuring jet energies. Scintillation and Cerenkov counters, hybrid detectors.

Unit 4. Particle Physics: Overview ofproperties, origin and classification of Elementary particles, type of interactions and conservation laws, Properties of mesons, Resonance particles, Strange particles and Strangeness quantum number, Simple ideas of group theory, Symmetry and conservation laws, CP and CPT invariance, Special symmetry groups SU (2) and SU (3) classification of hadrons, Quarks, Gell- Mann- Okubu mass formula.

Text and Reference Books

Introduction to nuclear Physics by H. Enge
Theoretical Nuclear Physics by J.M. Blatt and V.F. Weisskopf
Particle Physics: An introduction by M.Leon
Nuclear & Particle Physics: An Introduction by B.Martin
Introduction to Particle Physics by R. Ones.
Introducing Nuclear Physics by K. S. Krane
Nuclear Physics: Theory and Experiments by R.R. Roy and B. P. Nigam
Fundamentals of Nuclear Physics by B.B. Srivastava
Nuclear Physics by D.C. Tayal
Nuclear Physics in A Nutshell by C. A. Bertulani

M.Sc. PHYSICS (IV SEMESTER): PHYSICS OF NANOMATERIALS

Course Objectives:

The primary objectives of "Physics of Nanomaterials" course are:

- To understand the Physics of materials (especially engineering materials/IT materials: Semiconductors, insulators & metals) at nanometer scale.
- To understand the phenomena of QSE and Electron Confinement: Quantum well, Quantum wire & Quantum dot.

- To learn the different experimental techniques for determination of particle size: by XRD, Electron microscopy, absorption spectroscopy.
- To learn about the different methods of preparation of nanomaterials.

Course Outcomes:

On the successful completion of the course namely "Physics of Nanomaterials", the students will be able to understand the size, shape, and orientation dependent properties of different materials at the nanoscale (1 - 100 nm). In-addition, the student will also be able to acquire the ability to synthesize, and characterize of different materials for different solid state device applications. The main course outcomes are as follows:

- Able to understand the size dependent properties of materials.
- Able to determine the particle size of nanomaterials using different tools and techniques.
- Able to synthesize the desired NSM's for different applications using Top down and Bottom up approaches.

This course deals with the physics of nanostructured materials and determine the possible applications in medical and other industries related to device fabrication as far as the R&D of nanostructured materials is concern. Students may acquire skills to engineered the properties of materials by synthesizing the materials at nanometer scale. This course directly gives the employability towards the development of different devices and will be value-added course for others having interest in nanoscience & nanotechnology. The contents mentioned in Unit-3 and Unit-4 related to characterization and synthesis techniques will be helpful to generate the employability/skills/Start-up/self-employment.

Unit 1. Introduction to Nanoscience & Nanotechnology: Nanoscience & nanotechnology, Size dependence of properties, Moor's law, Surface energy and Melting point depression of nanoparticles, Measurement techniques of melting point depression, Qualitative idea of Free electron theory and band theory of solids, E-k diagrams, Energy gaps, Effective masses and Fermi surfaces, Localized particles, Donors, Acceptors and Deep traps, Exciton, Frenkel and Wannier-Mott exciton, Multiple exciton generation in semiconductor nanocrystals, Density of states, variation of density of states with energy and dimensions of crystal.

Unit 2. Quantum Confinement: Nanostructures & quantum physics, Quantum size effect, Nanomaterials structures, Quantum confinement of different nanostructures, Quantum well, Quantum wire and Quantum dot, Quantum mechanical treatment of nanostructures, Methods for fabrication of nanostructures.

Unit 3. Characterization techniques of Nanomaterials: Different techniques for determination of particle size, Determination of particle size using XRD, Diffraction under non-ideal conditions, Derivation of Scherrer's formula, Increase in width of XRD peaks of nanoparticles, Shift in absorption spectra peak of nanoparticles, Correlation between shift in absorption spectra peak and energy band gap of nanomaterials, Determination of energy band gap and particle size using

absorption spectra of nanomaterials, shift in photoluminescence peaks, Electron-Specimen interaction, Electron microscopy: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Probe microscopy (SPM), Scanning Tunneling Electron Microscopy (STEM) and Atomic Force Microscopy (AFM).

Unit 4. Synthesis of Nanomaterials: Key issues in the synthesis of Nanomaterials, Different approaches of synthesis, Top down and Bottom up approaches with examples of suitable techniques, capping agents, Cluster beam evaporation, Ball Milling, Carbon nanotubes (CNT)& graphene- Synthesis, Properties and Applications.

Text and References Books

Nanostructures & Nanomaterials, Synthesis, Properties & Applications by Guozhong Cao, Imperial College Press.
Introduction to Nanotechnology by Charles P. Poole, Jr. Frank J. Owens, John Wiley & Sons Inc. Publication.
Quantum Wells, Wires and Dots by Paul Harrison, John Wiley & Sons Ltd.
Quantum Mechanics for Nanostructures by Vlamidir V. Mitin, Dmitry I. Sementsov, Nizami Z. Vagidov (Cambridge University Press).
Quantum Dot Hetrostructures, by D. Bimberg, M. Grundman, N.N. Ledenstov.
Introduction to Nanoscience and Nanotechnology by Hornyak G.L., Tibbals H.F., Dutta J., Moore J.J., CRC Press.
Carbon Nanotechnology by Liming Dai
Carbon Nanotubes: Properties and Applications by Michael J. O'. Connell.

M. Sc. PHYSICS (IV SEMESTER): MATERIALS SCIENCE AND ENERGY DEVICES

Course objectives:

- To understand the phase diagrams to design and control of heat-treating procedures.
- To understand how materials structure is engineered from the knowledge of phase diagrams.
- To acquire a detailed knowledge of advanced engineering materials.
- To know the basics of photovoltaic energy conversion process.
- To acquire skills in materials selection and engineering design for various important solar cells.
- To learn construction of solar panels and their applications.

- To understand the fundamentals of hydrogen energy, hydrogen production and storage.
- To learn about various fuel cells and materials required for fuel cells.
- To learn the basics of energy storage in supercapacitors and batteries.
- To acquire detailed knowledge of important advanced supercapacitors and batteries.

Course Outcomes:

- Students will be able to design and interpret the phase diagrams.
- Students will have the knowledge of materials properties as function of microsructures.
- Student will get the fundamental knowledge of solar energy conversion process.
- Students will learn about the construction of solar panels and their domestic and industrial use.
- Students will understand about hydrogen energy and construction of various fuel cells and their applications.
- Student will be able to know the basics of energy storage in supercapacitors and batteries.
- Students will have the sufficient knowledge of construction of advance supercapacitors and batteries.
- Students will be able to select suitable materials and engineering use in solar energy system, hydrogen energy system, energy storage systems.
- All content of this course will impart skills for direct employability.

Unit 1. Classification of Materials and Phase Diagrams

Definitions and basic concepts of materials science, Overview of thermodynamic variables, quantities and equilibrium, Phase diagram, Gibbs Phase Rule, Lever Rule, Solubility Limit, microstucture, Interpretation of phase diagrams, Determination of phase amounts, Unary phase diagrams, Binary eutectic systems, Eutectoid and peritectic reactions, Iron-Carbon system, Homogeneous and heterogeneous nucleation.

Advanced Engineering materials, Alloys, Dielectrics, Polymers, Composites, Glasses, Ceramics and Biomaterials, Meta materials, Smart materials, Topological Insulators. Properties and applications.

Unit 2. Solar Energy and Materials Aspects

Importance of renewable energy, materials and devices in present technology, Basic of photovoltaic energy conversion, Optical properties of Solids, p-n junction solar cell, Transport equation, Current density, Open circuit voltage and short circuit current, Single crystal silicon and amorphous silicon solar cells, Elementary ideas of advanced solar cells (Tandem solar cells, Solid liquid junction solar cells, Dye sensitized, Organic solar cells), Introduction to PV panels, Domestic and industrial applications.

Unit 3. Hydrogen Energy

Photoelectrolysis and photocatalytic process, Brief discussion of various storage processes, Special features of solid hydrogen storage materials, New storage modes, Various factors relevant to safety, Hydrogen sensors, Use of hydrogen as fuel, Use in vehicular transport, Hydrogen for electricity generation, Fuel cells, Various type of fuel cells, Applications of fuel cell, Elementary concepts of hydride batteries.

Unit 4. Supercapacitors and Batteries

Capacitor principles, properties of capacitors, Electrochemical capacitors, Electrochemical interface, Double-layer capacitors: Li-ion based hybrid supercapacitors, applications of supercapacitors. Properties of batteries, introduction to battery technology, primary batteries, Secondary batteries, Li-ion and Ni-Ion based advanced batteries, applications of batteries.

Text and Reference Books:

1. Materials Science and Engineering by V. Raghavan.
2. Materials Science and Engineering: An Introduction byWilliam D. Callister Jr.
3. Fundamentals of Ceramics by M.W. Barsoum (Taylor & Francis).
4. Advanced Engineering materials by Sandra Kalveram.
5. Electrochemical Supercapacitors-Scientific Fundamentals and Technological Applications, by B. E. Conway.
6. Electrochemical Supercapacitors for Energy Storage and Delivery: Fundamentals and Applications, by Aiping Yu, Victor Chabot, Jiujun Zhang.
7. Supercapacitors: Materials, Systems, and Applications by François Béguin
8. Solar Cell Devices-Physics by Fonash.
9. Fundamentals of Solar Cells Photovoltaic Solar Energy by Fahrenbruch & Bube Phoptoelectrochemical Solar Cells by Chandra.
10. Hydrogen as an Energy Carrier Technologies Systems Economy by Winter & Nitch (Eds.).
11. Hydrogen as a Future Engery Carrier by A. Zuttel, A. Borgschulte and L. Schlapbach
12. Battery Reference book third edition by T.R. Crompton.
13. Advanced Batteries: Materials Science Aspects by Robert Huggins.
14. Handbook ofPhotovoltaic Scienceand Engineering byAntonio Luque.

M.Sc. PHYSICS (IV SEMESTER): NUMERICAL METHODS AND PROGRAMMING

Objectives:

The student should be made to:

- Be familiar with the MATLAB GUI and basic tool boxes
- Be familiar with arithmetic, logic and relational operations on matrix
- Aware about to find the roots of nonlinear equations by numerical methods
- Learn various methods to solve the matrices
- Learn about interpolation, least square fitting, Numerical differentiation, Integrations, ordinary and partial differential equations.

Outcomes:

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

- Perform data handling in MATLAB environment.
- Write arithmetic programs in MATLAB environment
- Solve the linear and non-linear algebraic equations, Eigen value problems, curve fitting and numerical solution of ordinary differential equations.
- Solve numerical integration & differentiation, curve fitting, Numerical solution of ordinary equations.

Unit 1. MATLAB: MATLAB environment, M-Files, Basic syntax and scalar arithmetic operations, variables, Working with formula, MATLAB control flow: if and loops, Functions, structured data types, file input output, defining functions, Graphics, 2D & 3D plotting in MATLAB, Linear algebra with MATLAB, solving a system of linear equations.

Unit 2. Roots of nonlinear equations: Linear and nonlinear algebraic and transcendental equations, Roots of functions, Bracketing and open end methods: Bisection method, Newton-Raphson method.
Matrices and solution of linear equations: Eigen values and eigenvectors of matrices, Power and Jacobi method, consistency of a system of linear equation, Gaussian elimination, LU decomposition method, matrix inversion, Jacobi iterative method, Gauss-Seidel method.

Unit 3. Interpolation and least square fitting: Finite differences, Newton's formula for interpolation, Gauss, Stirling, Divided differences, Newton's general interpolation formula, Lagrange's interpolation formula.Method of Least square curve fitting, straight line and quadratic equation fitting, curve fitting of curves $y = ax^b$, $y = ae^{bx}$, $xy^a = b$ and $y = ab^x$, curve fitting by sum of exponentials.

Unit 4. Numerical differentiation, integration and solution of ordinary differential equations: Differentiation of continuous functions, Trapezoidal rule, Simpson 1/3 and 3/8 rules, Boole's and waddles rules, Euler, Picard and Runge-Kutta methods, Finite element method (solve wave and heat equations).

Text and References Books

1. MATLAB programming for engineers, 4th edition by Stephen J. Chapman.
2. Introductory Methods of Numerical analysis by S.S. Shastri
3. Numerical Analysis by Rajaraman
4. Computational method in physics and engineering by Wong
5. Numerical Methods by E. Balagurusamy
6. MATLAB for Engineers, 3rd edition by Holly Moore

M.Sc. PHYSICS (IV SEMESTER): MICROWAVE ELECTRONICS, DIGITAL AND SATELLITE COMMUNICATION

Course Objective

The elemental objectives of this course are;

- To build up the concept from basics of microwave communications to modern applications
- To study digital communication systems (e.g., choose modulation scheme, coherent vs. non-coherent), constraints on data rate, bandwidth, power, and bit error rate

- To compute the power and bandwidth requirements of modern communication systems, including those employing Amplitude-Shift Keying (ASK), Phase-Shift Keying (PSK) and Frequency-Shift Keying (FSK modulation formats
- To enable the student to become familiar with satellites and satellite services.
- Study of satellite orbits and launching.
- Study of earth segment and space segment components

Course Outcomes:

Students will have achieved the ability to:

- Analyze microwave networks and measure their parameters.
- Explain the working of various microwave devices
- Identify the modern day applications of microwaves.
- Understand the performance of a baseband and pass band digital communication system in terms of error rate and spectral efficiency.
- Understand orbital mechanics and how to locate satellite w. r. t. Earth station
- Describe satellite subsystems
- Design link power budget for satellites

Unit 1. Microwave Tubes and Circuits: Generation of Microwaves by Vacuum Tubes; Limitations of Conventional Tubes, Microwave Linear Beam Tubes (O type); Klystrons amplifiers, Velocity Modulation, Basic principles of two cavity klystrons, Multicavity clystron amplifier and Reflex klystron oscillator and Travelling wave tube (TWT), Microwave Crossed Field Tube (M type) Magnetron, principles of operation of magnetrons

Unit 2. Semiconductor Microwave Devices and Circuits: Transferred electron devices, Ridley-Watkins-Hilsum (RWH) Theory, Gun effect diodes, Principles of operations, modes of operation, Avalanche Transit-Time Devices, Read diode, IMPATT diode, and TRAPATT diode.

Unit 3. Digital Communication: Pulse Modulation; Sampling theorem – Low Pass and Band Pass signals, Pulse Amplitude Modulation, Pulse Code Modulation, uniform and non-uniform Quantization of signals, Quantization error, Digital Modulation Schemes; Principle of Binary Phase Shift Keying (BPSK), Generation and Reception of BPSK, Bandwidth of BPSK Signal , Differential Phase Shift Keying (DPSK); DPSK Transmitter and Receiver, Bandwidth of DPSK Signal, Quadrature Phase Shift Keying (QPSK); QPSK transmitter and Receiver, Bandwidth of QPSK Signal, Binary Frequency Shift Keying (BFSK), BFSK Transmitter and receiver, Amplitude Shift Keying (ASK).

Unit 4. Satellite Communication: Introduction to Satellite Systems**,** Types of Satellites, Frequency Allocations, Orbital Mechanics; Laws governing satellite motion; Kepler's Laws, Describing the orbits of a Satellite, Locating the Satellite in the Orbit, Locating the Satellite with respect to the Earth, Orbital Elements, Antenna Look Angles determinations, Orbital

Perturbations, Satellite link power budget equation, system Noise, carrier to noise ratio for uplink and downlink, combined uplink and downlink carrier to noise ratio.

Texts and Reference Books

Microwaves by K.C. Gupta
Microwave Devices and Circuits by Samuel Y. Liao
Electronic Communication Systems by George Kennedy and Bernard Davis
Principles of Communication Systems by Taub and Schilling
Communication Systems by Simon Haykin
Digital Communications, second edition by J.S. Chitode
Satellite Communication by Timothy Pratt and Jeremy E. Allnutt

M.Sc. Physics (IV SEMESTER): DESIGN AND FABRICATION OF INTEGRATED CIRCUIT

Course Objectives:

- To understand the microelectronics.
- To know the process of preparation of electronic grade silicon and crystal growth.
- To understand the various process steps of silicon wafer fabrication.
- To learn the design of circuits using pattern transfer technology (lithography) on silicon wafer.
- To understand the process of ICs fabrication, Isolation, Contacts, Interconnections, and Packaging.

Course Outcomes:

- After completion of course, the students will learn about the integrated circuits (ICs) and technology.
- Students will understand the theory and experimental background of all the actual process like; wafer fabrication, doping, and pattern transfer, etc. used in IC fabrication.
- Students will also learn about exact deposition of thin films of metal, oxides and photoresists, wet/dry etching, and finally the isolation, interconnection, testing and packaging.
- The students will be able to design electronic circuits and devices for semiconductor/microelectronics industry purpose.
- All content of this course will impart skills for direct employability.

Unit 1. Semiconductor Subsrate for Integrated Circuits

An introduction to microelectronics fabrication, Classification of Integrated Circuits (IC), CMOS Process Overview. Metallurgical Grade Silicon (MGS) and Electronic grade silicon (EGS). Crystal growing methods, Silicon shaping, lapping, Polishing and wafer preparation,
Oxidation of silicon, Thermal dry oxidation and wet oxidation, Deal-Grove modal of oxidation, linear and parabolic rate coefficient, oxidation systems. Doping by Diffusion, Diffusion Process, Fick's Diffusion equation in one dimension, Analytic solution of Flick's law. Analysis of diffused profiles, Diffusion in SiO_2,Diffusion sources and systems., Ion implantation, Implantation system, Channeling, projected range, implantation damage, Junction formation, Annealing, Dopant Diffusion and Related Operations.

Unit 2. Thin Films: Metals and Nonmetals

Vacuum science and technology. Thin films and growth modes, Physical vapor deposition (PVD) methods: Thermal evaporation and electron beam evaporation systems, DC and RF sputtering system. Chemicals Vapor Deposition (CVD) methods: APCVD, LPCVD, PECVD and ALD technique, CVD Applications. Epitaxial growth, Epitaxy methods for thin film deposition: Vapor-Phase Epitaxy, Liquid Phase Epitaxy and Molecular Beam Epitaxy (MBE).

Unit 3. Photolithography, Photoresist Processing and Etching

Wafer Cleaning methods, Wafer Preparation method: HMDS Treatment for adhesion improvement of photoresist, photoresist spin coating method, soft and post backing of photo resist, Negative photoresist, Positive photoresist, Contrast and sensitivity of photoresist, Chemical Modulus Transfer Function (CMTF) of Photoresist, Resist Exposure (single, bi-layer and multi level photoresist exposure) and Resist Development, Hard Baking and Resist curing, Photolithographic Process Control.

Photolithography: An Overview, lithography, Photolithography source, Resolution and numerical aperture, Photolithographic methods: Contact, proximity and projection, Photo mask and mask Alignment, Limitations of optical lithography, Concept of phase-shift mask, Electron beam lithography, X-ray lithography and Ion Lithography. Dry etching and wet chemical for material removal, Reactive plasma etching, Ion milling.

Unit 4. Device Isolation, Contacts, Interconnections, Packaging and Yield

Junction and oxide isolation, LOCOS methods, Trench isolation, Ohmic Contact, Schottky Contact, Alloyed Contact, Multilevel Metallization, Planarization and advanced interconnects. Testing, Die Sepration, Die Attachment, Wire Bonding, Packages, Flip-Chip Process, Tape-Automated-Bonding Process, Yield, Uniform and Nonuniform Defect Densities.

Text and Refernece Books:

Integrated Electronics- Milliman and Taub
Microelectronics –Milliman and Gros
Thin Film Phenomena- K.L. Chopra
Hand Book of Thin Film- Marshel and Glang
VLSI Technology- S.M. Sze.
Silicon VLSI Technology: Fundamentals, Practice, and Modeling by J.D. Plummer

CH. CHARAN SINGH UNIVERSITY, MEERUT
FACULTY OF EDUCATION
SYLLABUS FOR TWO YEAR
BACHELOR OF EDUCATION

The present B.Ed. syllabus for two year programme has been designed on the current guidelines of NCTE, NCERT, UGC and MHRD with the view to make the student-teachers reflective practitioners. The programme is comprised of three broad inter-relatedcurricular areas :-

Group (A) : Perspectives in Education : Core Courses (CC)
Group (B) : Curriculum and Pedagogy : Pedagogy Courses (PC)
Group (C) : Experiences for Enhancing Professional Capacities (EPC)

Transaction of the courses is to be done using a variety of approaches, such as tasks and assignments, projects, group discussion, seminar, interactions with community in multiple socio-cultural environments, etc.

GROUP (A): PERSPECTIVES IN EDUCATION - CORE COURSES (CC)

These courses are intended to provide a conceptural understanding of relevant concepts and processes in teacher education and also situate them in the broader perspective of education and development.

CC (1) : Contemporary India and Education

This course deals with conceptual understanding about issues of diversity, inequality and marginalization in Indian society and the implications for education, with analyses of significant policy debates in Indian education.

CC (2) : Philosophical & Sociological Perspectives of Education

This course deals with philosophical and sociological issues and provides an opportuniy to understand and reflect on the vision of education as well as cultural context within which education operates.

CC (3) : Growing up as a Learner

This course deals with individual development, nature and process of learning and an understanding of how learning and cognition are closely inter-related through out individual development process.

CC (4) : Teacher, Teaching and Technology

This course deals with rules and expectations of teachers in the form of accountability and code of ethics and the nature and various aspects of the teaching process in view of the professional development of the teacher.

CC (5) : Creating an Inclusive School

This course deals with understanding of the cultures, policies and practices that need to be addressed in order to create an inclusive school.

CC (6) : Gender, School and Society

This course deals with meaning and experience of being a boy or a girl across different social groups, regions and time-periods. It also deals with gender inequalities through a variety of institutions such as the family, caste, religion, culture, the media and popular culture, law and the state.

CC (7) : Knowledge, Language and Curriculum

This course deals with meaning, nature and sources of knowledge, to develop reading for comprehension and writing skills & for curriculum development.

CC (8) : Work Education, Gandhiji's Nai Talim and Community Engagement

This cource deals with Gandhiji's ideas on Experiential Learning, Nai Talim, Work Education and Community Engagement. This course is included as all-round development of children is best obtained through experiences and Education is effective only when it is transacted through work and craft and not only through books and abstraction.

GROUP (B): CURRICULUM AND PEDAGOGY - PEDAGOGY COURSES (PC)

These courses pertain mainly to help student-teachers become effective teachers. For this, it offers the student-teachers not only reorganize one's previous understanding of one's subject of specialization but also the pedagogy as the integration of knowledge about the learner, the discipline and the societal context of learning, so that they may try out evolving a few learning situations and carry them out both in simulated as well as real situations.

PC (1) & PC (2) : Pedagogy of School Subjects - I & II

These courses intend to enable student-teachers to recognise the nature of knowledge in various subject areas (Sciences-Physical/Biological/Mathematics, Social sciences,Languages-Hindi/English/Sanskrit) and will help in developing understanding of the pedagogical requirements in various teaching-learning situations. Each student-teacher will take up two subject areas of his/her own choice.

PC (3) : Assessment for Learning

This course intends to lead to an understanding and appreciation of the relevance of assessment the how and why of it, as well as develop necessary competence in envolving appropriate assessment modes in line with learning objectives. It also clarifies the significant shift in emphasis of the terms 'assessment for learning' as against 'assessment of learning'.

PC (4) : Optional Course – any one of the following

(i) Educational Administration and Management.
(ii) Guidance and Counselling
(iii)Environmental Education
(iv)Computer Education
(v) Health,Physical Education & Yoga
(vi) Life Style Management

PC (5) : Preparation to Function as a Teacher (Teaching Skills)

This is visualialised as a shorter-duration initial experience (5 weeks) of student-teachers to train in lesson-planning based on constructivistic approach, micro-teaching skills and playing the role of teacher in simulated condition as well as in real classroom situation. It will help him/her to prepare himself/herself as a teacher possessing teaching Skills.

PC (6) : School Internship

This is visualized as a longer-duration field experience (16 weeks) of student-teachers supported by relevant interactive exposures within the school. During this period he/she will observe school functioning and prepare Journal containing day-to-day report about all activites including evaluation tools and also perform an Action Research Project based on any school problem. It will help him/her to become a professional teacher, possessing teaching-competence.

GROUP(C):EXPERIENCES FOR ENHANCING PROFESSIONAL CAPACITIES (EPC)

Apart from conceptual and practical learning gained through Core Courses (CC) and Pedagogy Courses (PC), student-teachers need to develop professional competencies and to experience the fact that the teacher is much more than someone who teaches a subject. The teacher is potentially a participant in the wider education system and he/she may play not only a proactive role in the community life of the school but also as an agent of social development and social transformation. It includes a number of experiences that will enhance the capacity of student-teachers in six essential dimensions:

EPC 1 : Strengthening Language Proficiency.
EPC 2 : Art and Aesthetics
EPC 3 : Reading and Reflecting on Texts.
EPC 4 : Unerstanding of ICT.
EPC 5 : Scouting and Guiding.
EPC 6 : Working with Community.

Task and Assiguments that run through all the courses CC 1-8 and PC 3-4.

Course Structure

1.	**Course Status**	**Core Course (CC-1)**
2.	**Course Number**	**I**
3	**Course Title**	**CONTEMPORARY INDIA & EDUCATION**
4	**Course Code**	**E-101**
5	**Period per week**	**06**
6	**Weightage**	**100 marks**
7	**Course Objectives**	**To enable student teacher to-** • Understand that development of education is influenced by socio-political forces of the time. • Acquire the knowledge of features of education in ancient, medieval and pre-Independent period in India with their strengths and weaknesses. • Understand the contribution of various Committees and Commissions on education set up from time to time in the economic development of India. • Appreciate the developments of Indian Education in the Post Independent Period.

Course Contents

Unit I : Education in India

Vedic Period, Buddist Period and Medieval Period.

Unit II : Policy Framework of Education in Pre-Independent Period

Macaulay's, Minutes (1835), Woods Despatch (1854), Hunter Commission (1882) and Indianisation of Education, National Education Movement, Lord Curzon Policy (1902), Gokhle Bill (1910), Sadler Commission (1917), Hartog Committee (1929), Basic Education (1937), Sargent Report (1944) **:**

Unit III : Policy Framework of Education in Post-Independent Period

- University Education Commission (1948-49)
- Secondary Education Commission (1952-53)
- Indian Education Commission (1964-66) in the context of Industrialisation

Course Structure

1.	**Course Status**	**Core Course (CC-2)**
2.	**Course Number**	**II**
3	**Course Title**	**PHILOSOPHICAL & SOCIOLOGICAL PERSPECTIVES OF EDUCATION**
4	**Course Code**	**E-102**
5	**Period per week**	**6**
6	**Weightage**	**100 marks**
7	**Course Objectives**	**To enable student-teacher to-** • Answer three basic questions-what ? why & How of the Education. • Develop an understanding of contribution of Indian & Western philosopher. • Build their own view about different Indian Religion and respect them. • Describe the role of Education in desirable social change and socio-economic development. • Transform one-self and society to empower people to assure responsibilities for creating sustainable future.

Course Contents

Unit I : Education and knowledge

- Education – meaning, nature and modes-formal, Informal and Nonformal
- Purposes of Education-Individual Development or social Transformation
- Knowledge-meaning and ways of knowing,
- Forms of knowledge-Local & universal, concrete & Abstract, Theoretical & Practical, Contextual & Texual, School & out-of-school.

Unit II : Education and Philosophy

- Philosophy of Education-meaning and significance in the context of Aims of Education, Curriculum, methods of Teaching & discipline etc.

Course Structure

1.	**Course Status**	**Core Course (CC-3)**
2.	**Course Number**	**III**
3	**Course Title**	**GROWING UP AS A LEARNER**
4	**Course Code**	**E-103**
5	**Period per week**	**6**
6	**Weightage**	**100 marks**
7	**Course Objectives**	**To enable student-teacher to** • Acquire the basic principles of psychology of learners. • Understands learner characteristics and implications for teaching-learning. • Understand learner's mental health problems & choose appropriate strategis to cope with such problems. • Apply various psychological principles and approaches to learning. • Appreciate the role of psychology in the teaching-learning process.

Course Contents

Unit I : Psychology and learner

- Psychology – Its meaning, Nature & scope.
- Educational Psychology – Meaning, Scope and its relevance for teachers, teaching and learning.
- Individual Differences-Concept and Nature.
- Exceptional Children-Mentally retarded, Backward, Delinquent, Gifted & Slow learner.

Unit II : Human Development

- Concept & Stages of Development – Infancy, Childhood, Adolescence
- Types of Development- Physical, Cognitive social, Emotional, moral with reference to Piaget.

Course Structure

1.	**Course Status**	**Core Course (CC-4)**
2.	**Course Number**	**IV**
3	**Course Title**	**TEACHER, TEACHING AND TECHNOLOGY**
4	**Course Code**	**E-104**
5	**Period per week**	**6**
6	**Weightage**	**100 marks**
7	**Course Objectives**	**To enable student-teachers to-** • Acquire theoretical basis of educational technology and to develop awareness about recent developments in the areas of educational technology. • Equip them with various technologies to apply for improving instructional practices • Develop teaching skill required for effective instructional and institutional management. • Manage teaching and learning effectively and efficiently. • Identify and implement instructional strategies in different situations.

Course Contents

Unit I : Technology and Teaching

- Educational Technology-meaning, concept & types-hardware, software, systems approach
- Types of Educational Technology-Teaching technology, Instructional technology, Behavioural technology, Information and Communication Technology.

Unit II : Task of Teaching

- Phases of Teaching and its Operations-Pre-active, Inter-active & Post-active.
- Levels of Teaching-Memory, Understanding & Reflective.

Unit III : Teaching Aids & Teaching

- Teaching Aids-Meaning, Need, Types- Projected, Non-projected & Electronic.
- Edgar Dale's Cone of experience
- Audio-visual Equipments-OHP, Radio, Television, Computer, LCD Projector, etc.

Course Structure

1.	**Course Status**	**Core Course (CC-5)**
2.	**Course Number**	**IX**
3	**Course Title**	**CRITATING AN INCLUSIVE SCHOOL**
4	**Course Code**	**E-301**
5	**Period per week**	**3**
6	**Weightage**	**50 marks**
7	**Course Objectives**	**To enable student-teachers to :** • Understand inclusive education- concept and nature. • Understand the global and national commitments towards the education of children with diverse needs • Prepare condusive teaching learning environment in inclusive schools. • Identify and utilize existing resources for promoting inclusive practice.

Course Contents

Unit I : Introduction to Inclusive Education

- Defination, concept needs and importance of Inclusive education.
- Historical perspectives on education of children with diverse needs.
- Difference between Special education, Integrated education and Inclusive education.
- Policies and Legislations for Inclusive Education and Rehabilitation, Government scheme and provisions.

Unit II: Children with Diverse Needs

- Defination and characteristics of children with divers needs.
- Sensory (hearing, visual and physically challenged)
- Intellectual (gifted, talented and mentally challenged)
- Developmental disabilities (autism, cerebral palsy, learning disabilities)
- Social and emotional problems
- Scholastic backwardness, under achievement, slow learners
- Children belonging to other marginal groups.
- Role of teachers for meeting these diverse needs of learners.

Course Structure

1.	**Course Status**	**Core Course (CC-6)**
2.	**Course Number**	**X**
3	**Course Title**	**GENDER, SCHOOL AND SOCIETY**
4	**Course Code**	**E-302**
5	**Period per week**	**3**
6	**Weightage**	**50 marks**
7	**Course Objectives**	**To enable students-teachers to :** • Sensitize the future teachers towards basic understanding of various key concepts of gender studies. • Learn about gender issues in school, curriculum and textual materials across disciplines, pedagogical process and its interaction with class, caste, religion and region. • Help them understand the contribution of women in social, economic & political development of the society. • Apply the conceptual tools learn regarding gender & sexuality to understand issues related to sexual harassment at the workplace and child sexual abuse.

Course Contents

UNIT I : Gender Issues :Key Concepts

- Gender, sex, sexuality, patriarchy, masculirity and feminism – in cross cultural perspectives.
- Gender bias, gender stereotyping and empowerment.
- Equity and Equality in relation with caste, class, religion, ethnicity, disability and region.

UNIT II : Gender Inequality in the Schools

- In the structure of knowledge.
- In the development of curriculum, Gender and hidden curriculum.
- Gender in text and context (text books inter sectionlity with other disciplines, classroom processes including pedagogy).
- In the class room.
- In the management of school.
- Teachers as agent of change.

Course Structure

1.	**Course Status**	**Core Course (CC-7)**
2.	**Course Number**	**XI**
3	**Course Title**	**KNOWLEDGE, LANGUAGE & CURRICULUM**
4	**Course Code**	**E-303**
5	**Period per week**	**03**
6	**Weightage**	**50 Marks**
7	**Course Objectives**	**To enable students teacher :** • To examine the Epistemological basic of educaton • To understand the concept and principles of curriculum development • To understand the formulation of new curriculum • To develop the ability to read & comprehend • To develop writing skill

Course Contents

Unit I : Knowledge

- Epistemology – meaning, philosophical basic of knowledge according to Indian & Western Philosophy
- Knowledge – Nature and sources, validity of knowledge
- Differences between knowledge and skill, Teaching and Training, Knowledge and Information, reason and belief
- Chronological review on knowledge generation, myth based faith and logical based knowledge, various structures of society and knowledge patterns and their relationship

Unit II : Language and Reading Comprehension

- Need & Importance
- Types of reading : skimming & scanning
- Strategies for effective reading, mechanism for reading, loud reading, silent reading.
- Schema Theory of reading

Unit III : Developing Writing skills

- Need & Importance
- Making - Reading writing connection

Course Structure

1.	**Course Status**	**Core Course (CC-8)**
2.	**Course Number**	**XII**
3	**Course Title**	**WORK EDUCATION, GANDHIJI'S NAI TALIM AND COMMUNITY ENGAGEMENT**
4	**Course Code**	**E-304**
5	**Period per week**	**03**
6	**Weightage**	**50 Marks**
7	**Course Objectives**	**To enable students-teachers to-** • appreciate the concept of work and dignity of labour. • sensitize the importance of the Gandhiji's ideas on Nai Talim • compatible with various curriculum frameworks related to Nai Talim. • analyze the school education programmes and policies, which incorporate local community engagement aspects. • reflect the various Nai Talim approaches in every walk of life. • participate efficiently in the local community services. • analyze the school education programmes and policies, which incorporate local community engagement aspects. • reflect the various Nai Talim approaches in every walk of life.

Course Contents

Unit-I: Work and Education

- Meaning and concept of Work-Significance of work and labour
- Work and livelihood
- Work with happiness and satisfaction
- Work Education: Purpose, social, economic and pedagogical values of work and craft education
-

Unit-II: Gandhiji's Nai Talim

- Gandhiji's ideas on Education - Basic principles of Nai Talim
- Experiential learning: Meaning and concept

Course Structure

1.	**Course Status**	**PEDAGOGY COURSES : PC- 1 & PC- 2**
2.	**Course Number**	**V&VI**
s3	**Course Title**	**TEACHING OF LANGUAGES**
4	**Course Code**	**E-201 TO E-203**
5	**Period per week**	**6**
6	**Weightage**	**100 marks**
7	**Course Objectives of Languages**	To enable student-teachers to- • Understand about the nature and characteristics of a language and mothertongue and the use of language. • Practice the required skill and their insterlinks for mastering a language. • Understand the various approaches for planning for successful language teaching. • Understand the Approaches for teaching different aspects of language. • Understand the Aids and other similar available material that could be used for teaching language. • Practice the teachnique of obtaining feedback for self-evaluation and evaluation of stuent's success in learning and using the language.

Course Structure

1.	**Course Status**	**Pedagogy Courses : PC-1 & PC -2**
2.	**Course Number**	**V & VI**
3	**Course Title**	**PEDAGOGY OF SOCIAL SCIENCES**
4	**Course Code**	**E-204**
5	**Period per week**	**06**
6	**Weightage**	**100 marks**
7	**Course Objectives**	**To enable the student teacher to-** • Understand concept, meaning and scope of social sciences. • Get acquainted with appropriate methodology as applicable to social sciences. • Prepare unit plan and lesson plan. • Acquire skill in teaching social sciences. • Acquire knowledge of various evaluation procedures and to device effective evaluation tools. • Acquire the ability to develop instructional support materials.

Course Contents

Unit I : Nature and Scope of Social Sciences

- Social sciences and social studies: Course subjects of social sciences - History, Civics, Geography and Economics, inter-relationship between them.
- Rational for incluiding these area in school curriculum.
- Instructional objectives of Teaching Social Sciences at Secondary level.

Unit II : Methodology for Social Science Pedagogy

- Strategies for teaching Social Science in terms of specifics methods like Lecture, Question-Answer, Group Discussion, Project and Sourse Methods, Socialized Recitation and Supervised Study, Tutorials.
- Micro Teaching Skills- Introduction, Reinforcement, Probing Questioning, Stimulus Variation, Explaining, Black Writing etc.
- Selecting and using teaching aids: Chalk boards, objects and specimen, histrionics, models, graphs, charts, maps, pictures, slides, films, filmstrips, audio-visual aids, projected aids: Slide projectors, Film Projectors, Overhead projectors, epidiascope.

Course Structure

1.	**Course Status**	**PEDAGOGY COURSES : PC1 & PC2**
2.	**Course Number**	**V & VI**
3	**Course Title**	**PEDAGOGY OF MATHEMATICS**
4	**Course Code**	**E-205**
5	**Period per week**	**06**
6	**Weightage**	**100 marks**
7	**Course Objectives**	**To enable the pupil teacher to-** 1. Understand and appreciate the uses and significance of mathematics in daily life. 2. Learn successfully various approaches of teaching mathematics and to use them judiciously. 3. Know the methods of planning instruction for the classroom. 4. Prepare curricular activities as per the needs. 5. Appreciate and organize activities to develop aesthetics of mathematics. 6. Obtain feedback both about teaching as well as students learning.

Course Contents

Unit I : Entering into the Discipline

- Meaning & nature of mathemtics, Use & Significance of Mathematics.
- Contribution of some great mathematicians - Aryabhatta, Bhaskaracharya, Ramanujam, Euclid, Pythagorus & Rene Decarte.

Unit II: Aims and Objectives of Mathematics Teaching

- Aims and objectives of teaching mathematics at secondary and senior secondary levels.
- Taxonomy of Educational Objectives.
- Objectives of teaching mathematics in terms of behaviour outcomes.

Unit III : Methodology for Mathematics Teaching

- Methods of Teaching: Inductive- Deductive, Analytic- Synthetic, Problem solving, Heuristics, Project & Laboratory Method.
- Techniques of Teaching: Oral, Written, Drill, Home-Assignment, Supervised study.
- Micro teaching Skills-Introduction, Reinforcement, Probing Question, Stimulus variation, Explaining, Black-Board Writing etc.

Course Structure

1.	**Course Status**	**PEDAGOGY COURSES : PC1 & PC2**
2.	**Course Number**	**V & VI**
3	**Course Title**	**PEDAGOGY OF PHYSICAL SCIENCE**
4	**Course Code**	**E-206**
5	**Period per week**	**06**
6	**Weightage**	**100 marks**
7	**Course Objectives**	**To enable the Student teachers to-** • Develop a broad understanding of the principles and procedures used in modern physical science education. • Develop their essential skill for practicing modern physical science education. • Develop their skills necessary for preparing international accessories. • Prepare acceptance lesson models which lay down this procedure to the acceptance for preparing designs for lesson. • Manage introduction activity in such a way that the vast majority of the learners attain most of the objectives.

Course Contents

Unit I: Concept, Nature and Importance

- Meaning and nature of physical science, Path tracking discoveries and land mark development in science, Impact of science on modern communities, Globalization and Science.
- Justification for including science as a subject in school curriculum, Eminent Indian and world Scientists - an introduction, Professions in the area of science.

Unit II: Aims and Objectives of Teaching Physical Science

- General aims and objectives of teaching physical science at secondary and senior secondary school stage. Instructional objectives with special emphasis on Bloom's Taxonomy.
- Concept of entering and terminal behavior, defining desired outcomes (statements of objectives) for different levels of education like primary, upper primary, secondary and senior secondary.

Course Structure

1.	**Course Status**	**PEDAGOGY COURSES : PC-1 & PC-2**
2.	**Course Number**	**V & VI**
3	**Course Title**	**PEDAGOGY OF BIOLOGICAL SCIENCES**
4	**Course Code**	**E-207**
5	**Period per week**	**06**
6	**Weightage**	**100 marks**
7	**Course Objectives**	**To enable the Student-teachers to-** • Develop broad understanding of principles and knowledge used in biology science. • Develop their essential skills for practicing biological science. • Know various approaches and methods of teaching life science. • Lesson planning of biological science properly. • Prepare tools for evaluation in biological sciences.

Course Contents

Unit I : Nature, concepts and importance

- History and nature of biological science.
- Importance of biological science for environment, health and peace.
- Interdisciplinary linkage of biological science and other school subjects.
- Value of biology in our lives.
- Four Indian eminent biologists and their discoveries.

Unit II : Objectives of Biology Teaching

- General aims and objectives of teaching biology difference between aims and objectives. Bloom's taxonomy of educational objectives.
- Writing objectives in terms of learning outcomes (behavioural term) for different levels of school teaching VIII, IX and X classes-RCEM approach of writing objectives.

Unit III : Exploring learning

- Inductive and deductive approach. Different methods and techniques of teaching biology.
- Teacher centered approaches-lecture, demonstration, lecture cum demonstration.
- Child centered approach-project method, heuristic, problem solving, assignment.

Course Structure

1.	**Course Status**	**PEDAGOGY Course :PC-1 & PC-2**
2.	**Course Number**	**V & VI**
3	**Course Title**	**PEDAGOGY OF COMPUTER SCIENCE**
4	**Course Code**	**E-208**
5	**Period per week**	**06**
6	**Weightage**	**100 marks**
7	**Course Objectives**	**To enable the student-teacher to –** • Develop a broad understanding of the principles and procedures used in computer science education. • Develop their skills necessary for preparing international accessories. • Know the methods of planning instruction for the classroom. • Learn successfully various methods of teaching computer science and use them judiciously. • Manage introduction activity in such a way that the vast majority of the learner attains most of the objectives

Course Contents

Unit I: Historical perspective, Aims and Objectives of Computer Science

- Historical Development of Computer (hardware and software)
- Present status of computer science as a school subject.
- Significance of teaching computer science at secondary/senior secondary schools.
- Aims and Objectives of teaching computer science-
    - Aims and Objectives of teaching computer science.
    - Classification of educational objectives (Bloom's taxonomy).
    - Statement of specific objectives in behavioral terms.

Unit II: Development of Curriculum in Computer Science

- Principles and rationale of curriculum development, organizing the syllabi both logically and psychologically according to the age groups of children.
- Organization of Computer Science Laboratory.
- Text book of Computer Science - qualities of a good text book of Computer Science.

Course Structure

1.	**Course Status**	**PEDAGOGY Course : PC-1 & PC-2**
2.	**Course Number**	**V & VI**
3	**Course Title**	**PEDAGOGY OF HOME SCIENCE**
4	**Course Code**	**E-209**
5	**Period per week**	**06**
6	**Weightage**	**100 marks**
7	**Course Objectives**	**To enable the student- teachers to-** • Understand the nature and scope of Home Science. • Acquaint with the objectives of teaching Home Science in secondary and higher secondary schools. • Acquire skills in planning a lesson with reference to methods and instructional materials and processing it effectively. • Understand the various methods and techniques that can be employed in the teaching of Home Science. • Develop a practical understanding of the technology of teaching Home Science and giving them practice in the use of various aids relating to the technology of teaching. • Get an insight into the organization of co-curricular activities like Home Science clubs and home science exhibition.

Course Contents

Unit I : Concepts

- The concept of Home Science: Meaning and components; place of Home Science in secondary education.
- Job opportunities in Home Science.
- Aims and objectives of teaching of Home Science.
- Correlation of Home Science with other school subjects.

Unit II: Pedagogical Analysis

- Foods, Nutrition and Health
- Child Care.
- Fiber and Fabric.
- Home Management-Importance of planning, principles of budget making.
- Hygiene and sanitation.

Course Structure

1.	**Course Status**	**PEDAGOGY Courses :PC-1 & PC-2**
2.	**Course Number**	**V & VI**
3	**Course Title**	**PEDAGOGY OF COMMERCE**
4	**Course Code**	**E-210**
5	**Period per week**	**06**
6	**Weightage**	**100 marks**
7	**Course Objectives**	**To enable the student- teachers to-** • Acquire knowledge of the terms and concepts used in the pedagogical analysis of Commerce and Accountancy • Understand lesson planning and evaluation aspects in teaching Commerce and Accountancy • Apply the knowledge in analyzing higher secondary Commerce and Accountancy contents in terms of the techniques and aids for the purpose of teaching Commerce and Accountancy • Develop skills in the preparation of lesson plan and construction of evaluation tools using the suitable techniques • Develop interests in learning recent developments in Commerce and Accountancy • Develop a desirable positive attitude towards the teaching of Commerce and Accountancy.

Course Contents

Unit I : Concept, Aims and Objectives of Commerce Teaching

- Meaning and scope of Commerce as a subject, Historical development of commerce education in India.
- Place of commerce in Indian school Curriculum
- Aims and Objectives of Commerce.
- Instructional Objectives -meaning, importance and specification of instructional objectives in behavioural terms (with respect to Bloom's Taxonomy).
- Objectives of Commerce education at High school and Intermediate levels (vocational & academic).

Unit II : Methods and Techniques of Commerce Teaching

- Various Methods of teaching Commerce-Lecture and discussion methods, Project method, Heuristics, Problem solving method etc.

Course Structure

1.	**Course Status**	**PEDAGOGY Courses : PC-3**
2.	**Course Number**	**XIII**
3	**Course Title**	**ASSESSMENT FOR LEARNING**
4	**Course Code**	**E-401**
5	**Period per week**	**03**
6	**Weightage**	**50 marks**
7	**Course Objectives**	**To enable student-teachers to** • Become cognizant of key concepts such as measurement & evaluation, assessment, test examination, formative & summative evaluation etc. • Be exposed to different kinds of assessment that aid student learning. • Have an idea of new trands in evaluation. • Learn the different characteristics of standardize test- Reliability, validity, Norms, etc. • Relate & use statistics in educational setting

Course Contents

Unit I: Measurement, Assessment and Evaluation

- Concept of Measurement, Assessment & Evaluation, Test Assessment, Examination, Formative & Summative Evaluation, Continuous and Comprehensive Evaluation
- New Trands: Open Book Examination, Grading, CGPA (Cummulative Grade Point Average), CBCS (Choice Based Criedt System).
- Distinction between 'Assessment for Learning' & 'Assessment of Learning'

Unit II: Assessment Tools

- Quantitative & Qualitative Tools.
- Contructing an Achievement Test- Preparation of Blue-Print, Item-Analysis and Try out**.**

Unit III: Standardization of Measuring Instrument

- Objectivity
- Reliability
- Validity and
- Norms.

Course Structure

1.	**Course Status**	**PEDAGOGY COURSE : PC-4 (OPTIONAL COURSE-ANY ONE)**
2.	**Course Number**	**XIV**
3	**Course Title**	**EDUCATIONAL ADMINISTRATION AND MANAGEMENT**
4	**Course Code**	**E-501**
5	**Period per week**	**03**
6	**Weightage**	**50 marks**
7	**Course Objectives**	**To enable student-teachers to-** • Acquaint the student teaches with the concept and concerns of educational administration. • Develop an understanding of the role of the headmaster and the teacher in school management. • Enable the students to understand to concept at importance of communication and its possible barriers in educational administration. • Enable the student teacher to critically analyse the administrative scenario in relation to the functioning of the other secondary schools of the area. • Acquaint the student teacher with the scientific practices of educational management and keep him to apply it in work situation

Course Contents

Unit I : Concept of Educational Administration and Management

- Nature, objectives and scope of Educational Administration.
- Concept of Educational Management, Human beings as inputs, process and product inputs.

Unit II : : **Basic functions of administration**

- Planning, Organizing, Directing and Controlling.
- Maintenance of discipline, control management.
- Co-ordination and growth development.
- Supervision and inspection, defects in the present supervision and inspection.

Unit III : Communication in Educational administration :

- Role of communication in effective management and administration.
- Methods of communication.

Course Structure

1.	**Course Status**	**PEDAGOGY COURSE : PC-4 (OPTIONAL COURSE-ANY ONE)**
2.	**Course Number**	**XIV**
3	**Course Title**	**GUIDANCE AND COUNSELING**
4	**Course Code**	**E-502**
5	**Period per week**	**03**
6	**Weightage**	**50 marks**
7	**Course Objectives**	**To enable student-teachers to-** • Develop an understanding of the need and importance of career information for the pupils. • Identify their role and function in locating, collecting, evaluating and disseminating career information for the use of pupils. • Develop an understanding of how one's ability, interests and aptitudes are related to world of work. • Know about the importantance of developing the right attitude and values at every stage of education.

Course Contents

Unit I : Meaning and concept of Guidance.

- Concepts, Need and Importance of Guidance.
- Principles of Guidance, Procedure of Guidance (Steps).
- Types-educational, vocational and personal.
- Techniques of Guidance: Observation, Interview & Sociometry.

Unit II : Meaning and concept Counseling

- Concepts, Need & Importance of Counseling.
- Principles of Counseling, Counseling process and Role.
- Directive, Non Directive &Electric Counseling.
- Techniques of Counseling: Lectures, Discussions & Dramatic.

Unit III : Meaning and concept Career Information

- Meaning of career and career information components of career information.
- Occupational information, information about education and opportunity and personal-social information.

Course Structure

1.	**Course Status**	**PEDAGOGY COURSE : PC-4 (OPTIONAL COURSE-ANY ONE)**
2.	**Course Number**	**XIV**
3	**Course Title**	**ENVIRONMENT EDUCATION**
4	**Course Code**	**E-503**
5	**Period per week**	**03**
6	**Weightage**	**50 marks**
7	**Course Objectives**	**To enable student-teachers to-** • Enable the student teacher understand about the concept of environmental education. • Develop in the student teacher a sense of awareness about the environmental pollution, and possible hazards and its causes and remedies. • Develop a sense of responsibility towards conservation of environment, bio-diversity and sustainable development. • Develop reasonable understanding about the role of school and education in fostering the idea and learning to live in harmony with nature. • Enable the students to understand about the various measures available to conserve the environment for sustaining the development.

Course Contents

Unit I: Basic Concept and Nature of Environment

- Meaning, scope and nature of environment. Natural and Man-made Environment.
- Ecosystem-Structure, function and its components.
- Energy flow in Ecosystem-Food chains, Food webs and Ecological pyramids.

Unit II: Natural Resourses and Associated Problems

- Forest Resourses – use and overexploitation. Deforestation-cause, effects and remedy
- Water Resourses- use and overexploitation of surface and ground water. Rain water Harvesting and watershed management.
- Mineral Resourses- use, exploitation and conservation, effect of mining on man & environment.
- Food Resourses- world food problems-changes caused by agriculture and overgrazing, effect of modern agriculture, fertilizers, pestisides, water logging and Salinity.
- Energy Resourses- growing energy need renewable and non-renewable energy sources, Conservation and alternate energy sourses.

Course Structure

1.	**Course Status**	**PEDAGOGY COURSE : PC4 (OPTIONAL COURSE-ANY ONE)**
2.	**Course Number**	**XIV**
3	**Course Title**	**COMPUTER EDUCATION**
4	**Course Code**	**E-504**
5	**Period per week**	**03**
6	**Weightage**	**50 marks**
7	**Course Objectives**	**To enable student-teachers to –** • Acquire knowledge of computers, its accessories and software. • Acquire the skills of operating a computer in multifarious activities pertaining to teaching. • Understand features of MS Office and their operations. • Develop skill in using MS-Word, Power points and Spread sheets. • Apply the knowledge gained in respect of to process various data of students as well as simple library financial transaction of the school. • Appreciate the value of CAI/CML packages on optional subjects and use them in class room instruction. • Acquire skill in accessing World Wide Web and Internet and global accessing of information. integrate technology in to classroom teaching learning strategies • Develop a broad understanding of the principles and procedures used in computer education.

Course Contents

Unit I: Meaning, Definition and Historical Perspectives of Computer

- Meaning and Definition of computer.
- Historical perspective.
- Computer Generations and its classification.
- Block diagram of a computer Peripherals, and working of a computer.

Unit II: Computer Hardware

- Input devices: Keyboard, mouse, joystick, touch screen, touch pad, magnetic ink character reader, optical mark reader, bar code reader, scanner, web camera etc.
- Output devices: Monitor, printers (line, serial, dot matrix, inkjet, and laser).

Course Structure

1.	**Course Status**	**PEDAGOGY COURSE : PC-4 (OPTIONAL COURSE-ANY ONE)**
2.	**Course Number**	**XIV**
3	**Course Title**	**HEALTH, PHYSICAL EDUCATION & YOGA**
4	**Course Code**	**E-505**
5	**Period per week**	**03**
6	**Weightage**	**50 marks**
7	**Course Objectives**	**To enable student-teachers to-** • Understand the concept of wholistic health and its various dimension and determinants of health. • Acquaint them to school health programme & its importance. • Sensitize the student teacher towards physical fitness & its importance. • Acquire the skills for assessment of physical fitness. • Introduce them to the philosophical bases of Yoga. • Understand the process of stress management through Yoga education. • Acquire the knowledge of teachniques of performing yogasana and develop the skill for the same.

Course Contents

Unit I : Health

- Introduction, Defination and meaning of Health.
- Dimension of Health.
- Determinants of Health.
- Importance of Balance diet.
- School Health Programme and role of teacher in development of Health.

Unit II : Physical Education

- Introduction, Definition and meaning of Physical Education.
- Objectives of Physical Education.
- Scope of Physical Education & allied areas in Physical Education.
- Need & Importance of Physical Education in different level of school.

Course Structure

1.	**Course Status**	**PEDAGOGY COURSE : PC-4 (OPTIONAL COURSE-ANY ONE)**
2.	**Course Number**	**XIV**
3	**Course Title**	**LIFE STYLE MANAGEMENT**
4	**Course Code**	**E-506**
5	**Period per week**	**03**
6	**Weightage**	**50 marks**
7	**Course Objectives**	**To enable student-teachers to** • Identify their life styles • Manage the challenges of day to day life. • Developing a successful personality

Course Contents

Unit I: Basics of Life Style

- Daily Routine
- View of Life
- Goal and Ideal of life.
- Values and commitment.

Unit II : Identification of Life Style

- Self-Evaluation
- Creative potentials
- Positive mental attitude
- Behavior skills and relationship

Unit III : Life Style Management

- Crisis of life style management
    - Refined view of life.
    - Stress-(causes/effect)
    - Negative emotions
    - Lack of self leadership
- Process of life style management
    - Change thinking pattern
    - Developing ideal routine
    - Creative and positive use of negativity
    - Spiritual practices.

PRACTICUM: COURSE - VII, VIII, XV &XVI

PC 5: Preparation to Function as a Teacher (Teaching Skills) (E-701)

During the first year, the teacher-preparation programme will offer the training amounting to a minimum of 5 weeks.

This will include:

- **One week workshop on Lesson-Planning based on constructivistic approach**: Covering different aspects like theory of lesson-planning, questioning, Defective Questions, Developing Question, How to put Question, How to receive Answers, Discipline, Role of Eye-control, etc.
- **One week workshop on Micro-Teaching:** Atleast 5 teaching skills will be mastered in each Pedagogy course like-Introduction, Reinforcement, Probing Question, Stimulus Variation, Explaining etc.
- **One week Practice-Teaching in Simulated condition:** in each Pedagogy course.
- **Two week Practice-Teaching in Real-Class room situation in a school:** For it, the student-teachers will be attached to a particular school as 'School Attachment', where they will deliver their lessons. These lessons will be observed by peers as well as by subject-supervisors daily, which will provide them feedback for the modification of their behavior.

This shorter period is to provide the student-teachers adequate exposure to have a 'feel' of dealing with teaching-learning. It will help him/her to develop the basic teaching skill required to deal with students effectively in classroom.

PC 6: School Internship (Teaching Competence) (E-703)

In the second year, there shall be a minimum of 16 weeks of intensive engagement with the school in the form of School Internship. For this, the student-teachers will go for 'School Placement', during which their role in the school is something like an apprentice and they shall work as a regular teacher & participate in all the school activities including planning, teaching and assessment, interacting with school-teachers, & children to understand the school in totality its philosophy & aims,organisation & management,the life of a teacher, the needs of the physical, mental and emotional development of children. They will be engaged in school functioning in all its aspects in consultation with the School-mentor, like-

- Participating in various 'out-of-class room' activities in school.
- Organizing events eg., cultural activities, debates, games, quiz, essay-competition, drama, etc.

- Preparation of School calendar, time-table, assessment schedule, evaluation tools etc.
- Preparing a suggested comprehensive plan of action for some aspect of school improvement.

School-Internship shall be designed to lead to the development of 'Teaching Competence of a professional, teacher dispositions and sensitivity.

Student-teachers are to be actively engaged in teaching at two levels, namely, upper primary & secondary. They should also be provided opportunities to teach in government & private schools with systematic support & feedback from the faculty.

It is important that the student-teachers will consolidate & reflect on their teaching experience during the school-internship.

- Student-teacher will maintain a **Journal (A Diary)** in which he/she records one's experiences & observation, etc. daily.
- Student-teacher will also maintain a **Portfolio** of all the activities like-details of daily-teaching eg., topic, date, class, objectives of teaching, resources used, assessment tools, homework given, etc.
- Student-teacher will work on a **Project on Action Research** based on any Educational problem of School, which will be selected in consultation with the concerned faculty supervisor.

Final Presentation

At the end of School-Internship each student-teacher will be expected to present:

- **The Journal** – Containing day-to-day report about different activities, like-teaching, events, etc. mentioned above.
- **The Portfolio** - Containing evidences (proof) of different activities & events in the form of different photographs, photocopies,etc.
- **The Project Report** – Containing the data, analysis and interpretation based on Action Research conducted by him/her.
- **Presentation of Teaching through PPT/OHP** - on any one topic of school subject.

These four things will be included in the evaluation of School-Internship

- The Journal of 50 marks.
- The Portfolio of 50 marks.
- The Project Report of 50 marks.
- Presentation of Teaching through PPT/OHP on any topic of School Subject of 50 marks

GROUP C: ENHANCING PROFESSIONAL CAPACITY
EPC COURSES

EPC 1 : STRENGTHERING LANGUAGE PROFICIENCY

(CODE: E-702)

Language is the medium for comprehending ideas, for reflection and thinking,as well as for expression and communication. Enhancing one's capacity in language proficiency is thus a vital need of student-teachers irrespective of the subject area that they are going to teach.

Objectives: To enable student-teachers to-

- Strengthen the ability to read correctly
- Strengthen the ability to pronunciate
- Strengthen the ability to write correctly
- Strengthen the ability to communicate correctly.

Activities :

One or two workshops on Language proficiency course on Hindi and English of 7-10 day each, may be organized. It may course the following content –

- हिन्दी भाषा (i) वर्ण–स्वर व व्यंजन ध्वनि, मात्राएं (ii) शब्द – पर्यायवाची व विलोम शब्द (iii) शब्द रचना–सन्धि, समास, उपसर्ग, प्रत्यय (iv) रूप विचार– संज्ञा, सर्वनाम, विशेषण, क्रिया क्रियाविशेषण, आदि (v) वाक्य विचार–विराम चिन्ह, आदि (vi) रचना–पत्र, प्रार्थना पत्र, निबन्ध कहानी आदि।
- English Language – (i) Alphabet-Vowel & Constonant sounds (ii) word-synonym & Anatonym (iii) Word Formation (iv) Parts of Speech – Noun, Pronoun, Adjective, Verb, Adverb, etc. (v) Sentence – Punctuation & Analysis (vi) Composition-Letter, Application, Essays, Story, etc.

EPC 2: ART AND AESTHATIC

(CODE: E-702)

The need to integrate arts education in the formal schooling of our students is to retainour unique cultural identity in all its diversity nd richness. The National curriculum Framework (2005) reminds us that the school curriculum must integrate varios domains of knowledge with a deep relationship between head, heart &hand so that the curriculum encompasses all,& is not separated from the co-curricular or extra-curricular.

Objectives : To enable student-teachers to-

- Gain direct experiences
- Develop motor skill
- Make students believe in the dignity of labour
- To nurture children's creativity and aesthetic sensibilities.

Activities:

An artist or artisam may be invited to organize a workshop on Art & Aestretics. The student-teachers may be asked to prepare atleast 5-items of different categories :-

- Paper meshing

- Pot Decoration
- Wall hanging
- Paper cutting
- Flower making
- Candle Making
- Stiching
- Knitting
- Embroidery
- Soft toys making
- Paper framing
- Weaving or printing of textiles
- Making of poster
- Making of Rangoli
- Making of Puppets etc.

EPC 3 : READING AND REFLECTING ON TEXTS
(CODE: E-702)

This course will serve as a foundation to enable student-teachers to read and respond to a variety of texts in different ways depending on the purposes of reading, like-personal or creative or critical or all of these.

Objectives : To enable student-teachers to-

- Develop study – habits
- Develop skill of reading &writing
- Develop skill of summarization
- Develop skill of note-taking.

Activities:

Student-teachers are expected to sit in the library regularly and to review at least 10-books of different categories in about 500 word each. These may be as follows –

- Review of text books related to core courses
- Review of reference Book related to core courses
- Review of Text Books related to Pedagogy courses
- Review of Reference to Book related to Pedagogy courses.
- Review of Policy Documents, Autobiography, Commission Reports, etc.
- Review of studies about school, historical books and other educational miscellaneous books.

EPC 4: Understanding of ICT

(CODE: E-704)

Preparing teachers to use technology in a classroom is an important step of ICT enabled education in the country. This course will focus on moving beyond computer literacy and ICT aided learning, to help student-teachers interpret and adabt ICTs in the teaching-learning process.

Objectives : To enable student-teachers to-

- Have a basic familiarity with computers
- Understand & appreciate ICT as an effective learning tool for learners
- Understand ICT as an emormous functional support to teachers.

Activities :

A workshop on ICT for 10-15 days way be organized or a provision of one period/week may be made daily in the time-table to learn and to practice in computer labs. Student-teacher are expected to learn the following:

- Use of radio and audio media in script writing, story-talling, etc.
- Use of TV & video in education
- Use of news paper in education
- Functional knowledge of operating computers- word processing, power point, excel, etc.
- Effective browsing of the internet for selecting relevant information.
- Downloading relevant material
- Competencies in developing software
- Developing PPT slide show for classroom use
- Use of available software or CDs with LCD projection for subject learning interactions
- Generating demonstrations using computer software.

EPC – 5 : SCOUTING AND GUIDING

(CODE : E-704)

This is an international programme to develop social-sensitivity and to make students dutiful towards the nation & the world so that they may serve the humanity.

Objectives : To enable student-teachers to-

- Develop the characteristics of good citizenship.
- Develop world Peace.
- Develop two feeling of dignity of labour.
- Make students self-reliant
- Develop the physical, mental & spirtual powers.

Activities:

This can be achieved through organizing a scouting camp of 6-7 days to impart training in-

- First-aid against fracture, snake bite poision, electric current, etc.

- Using safety-measures against fire, chemicals, electrical equipments, etc.
- Using compass & maps.
- Using different types of knots
- Constructing a bridge, etc.
- Different types of physical exercise etc.

EPC 6: WORKING WITH COMMUNITY
(CODE: E-704)

This programme gives opportunity to attach with and to solve the problems of the community to make the student-teachers sensitive and aware about the society.

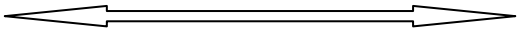
Objectives: To enable student-teachers to

- develop social-sensitivity among student-teachers
- develop sympathy with the poor and the people below-poverty-line.
- Develop awareness about the environment.
- To have the positive attitude toward the neglected class.

Activities:

This can be achieved by organizing a number of programme for the welfare of the community, like –

- To educate the dropouts & Adults (Literate India)
- To educate the people of slum areas to take the nutritious diet. (Quit Mal-nutritious).
- To make the people learn the importance of small family norm (chota pariwar sukhi pariwar)
- To make the people learn the importance of the girls-child & its education for the Family and the society (Beti Bachao Beti Padhao)
- To motivate the people to grow more plants (Green India)
- To motivate the people to keep the city and the public places clean (Clean India)
- To motivate the people to save river and ponds (Clean Water).



PROGRAMME OUTCOMES (PO's)

Economics as a subject is long-established discipline whose relevance to the world of business, government, international relations and academia is widely acknowledged. The M.A. Economics Programme reflects new developments and dimensions in the Economics discipline. The curriculum has a strong theoretical and quantitative focus with all students being trained in the use of computers and statistical software that they find useful in their professional careers in academics, research institutions, government, and other sectors of the economy. The MA Economics programme is semester-based under choice based credit system (CBCS) and includes a large number of elective courses with specialization in different fields of choice. Entry into the MA Economics is based on entrance test/merit along with graduate degree in Economics and allied disciplines. After completing the master in economics the student may have career/employment opportunities in academic and research institutions in the fields of economics, MNC's, industrial organization, banking and non-banking financial institutions, etc.

PROGRAMMESPECIFICOUTCOMES (PSO's)

PSO-1: It is expected that a student after successful completion of MA Economics would be equipped with tools to generate knowledge, understand the advances in economic theories and the knowledge based decision making.

PSO-2: The programme has a strong theoretical and quantitative focus with an emphasis on empirical applications, which are directly related to employment of the students.

PSO-3: The students who undergo this programme are able to understand the challenges, problems & issues prevailing in economic matters, critically analyze policies and programmes of government and to develop appropriate practical skills suitable for public sector needs as well as private sector.

PSO-4: After the completion, there are plenty opportunities to get employment in the various government and non-government institutions viz.; public sector organizations, professionals in the various field of the economy.

PSO-5: Students of master in Economics can participate and succeed in competitive examinations namely; Indian Civil Services, Indian Economic Services (IES), Banking Services, Provincial Services, UGC-JRF/NET etc. and he/ she can also pursue higher research degrees i.e. Ph.D in Economics and Development Economics.

PSO-6: At the end of the Programme, the student should be able to bring to bear these skills to the Modeling and analysis of a wide range of theoretical and applied problems in Economics and to the understanding and solution of real world economic and social problems. These techniques will be helpful to generate the employability skills in the students.

Programme/Class: M.A.	Year: First	Semester: I
Subject: ECONOMICS		
Course Code: ECOC101	**Course Title: Micro Economics**	**(Theory)**

Course Objectives: This paper analyses the economic behaviour of individuals, firms, and markets. It is mainly concerned with the objective of equipping the students in a rigorous and comprehensive manner with the various aspects of consumer behaviour and demand analysis, production theory and behaviour of costs, the theory of traditional markets and equilibrium of firms in modern markets characterized by few sellers.

Credits: 5	Core
Max. Marks: 25+75 {Internal + External (Practical)}	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	Introduction and measurement - Basic Economic Problem - Choice and Scarcity; Deductive and Inductive Methods of Analysis; Positive and Normative Economics; Economic Model. The theory of Consumer's Behaviour- Properties of indifference curve; Price, Income and Substitution effects - Hicks and Slutsky Approach and Applications, Derivation of demand curves and income consumption curves from indifference curves, Concept of elasticity of demand and its application, Revealed Preference Theory.	10
II	Theory of Production and Cost in short-run and long-run - Isoquants-Least cost combination of inputs; Expansion Path, Concepts of product line-Isocline and ridge line, Multiproduct firm; Elasticity of substitution; Euler's theorem; Cobb-Douglas and CES Production Functions, Theories of costs – traditional and modern; Derivation of cost functions from production functions; derived demand for production factors.	10
III	Theory of Firm - Perfect competition – short-run and long-run equilibrium of firm and industry; Monopoly-short and long-run equilibrium, price discrimination, welfare aspects, monopoly control, and regulation; concept of natural monopoly, bilateral monopoly and monopsony.	10
IV	Monopolistic competition - general and Chamberlin approaches to equilibrium, equilibrium of the firm and the group with price variation, product differentiation and selling costs, excess capacity under monopolistic and imperfect competition, criticism of monopolistic competition; Oligopoly-Non-collusive (Cournot, Bertrand, Edgeworth, Chamberlin, kinked demand curve and Stackelberg's solution) and collusive (Cartels and mergers, price leadership and basing point price system) models.	10
V	Distribution - Determination of rent, wages, interest and profit; Neo-classical approach-Marginal productivity theory; Elasticity of technical substitution, technical progress and factor shares; Theory of distribution in imperfect product and factor markets; Product exhaustion theorem; Macro theories of distribution-Ricardian; Kalecki and Kaldor's.	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Suggested Readings:

Basic Reading List :

- Gould & Lajear — Micro Economics
- Richard A. — Bilas Micro Economic Theory
- Paul, A. Samuelson — Economics
- R. H. Lelftwich — The Price system and Resource Allocation.
- A. Koutsoyiannis — Modern Micro Economics
- Joseph E. Stiglitz — Economics, W.W. Norton & Company, New York, London.

Additional Reading List :

- J. R. Hicks — Value and Capital
- Milton Friedman — Price Theory – A Provisional Text.
- W. J. Baumol — Economic Theory & Operations Analysis
- Joan Robinson — The Economics of Imperfect Competition.
- W. J. L. Ryan — Price Theory
- K. E. Boulding — Economic Analysis, Volume I.
- E. H. Chamberlin — The Theory of Monopolistic Competition
- Choudhary, Kalyanjit Roy — Modern Micro Economic Theory, Pragati Publication, Delhi.
- Samuelson & Nordhaus — Economics, Tata McGraw-Hill Publishing Company Ltd., New Delhi

This course can opt as an elective/ value-added course by the students of the following subjects: Open to all

Programme/Class: M.A.	Year: First	Semester: I
Subject: ECONOMICS		
Course Code: ECOC102	**Course Title: Macro Economics**	**(Theory)**

Course Objectives: The functional link between the large aggregates is established by Macro Economics, often known as aggregative economics. Recent events have given the macro analysis such weight that it is now thought that a proper understanding of the various economic issues and policies depends on one's prior acquaintance with the macroeconomic theoretical framework. Macroeconomics is a body of factual economic knowledge as well as a scientific method of analysis. The "Macro Economics" paper equips postgraduate students to the tools they need to comprehend systemic facts and the most recent theoretical advancements for empirical investigation.

Credits: 5	Core
Max. Marks: 25+75 {Internal + External (Practical)}	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	Nature & scope of Macroeconomics and National Income: Nature and scope of Macro-economics, Macro-Statics & Macro-dynamics; Circular Flow of Income in two, three and four-sector economy including foreign spending; various concepts of national income, measurement of national income; Social accounting.	10
II	Theories of Employment and Consumption (a) Theories of Employment – Say's law of market, wage-price flexibility of full employment, the classical theory of employment and Keynesian theory of income and employment. (b) Consumption Function: Psychological law of consumption - implications of the law; short-run and long-run consumption function; Empirical evidence on consumption function; Income consumption relationship - absolute income, relative income, permanent income hypotheses, and life cycle. Concept and determinants of investment functions.	10
III	Theory of Inflation and Business Cycles: (a) Theory of Inflation: Concept of inflation – demand pull and cost push inflation; Classical, Keynesian and Monetarist approaches to inflation; Philips curve analysis - Short and long-run Philips curve; (b) Business Cycles: Theories of Schumpeter, Kaldor, Samuelson and Hicks.	10
IV	Demand and Supply of Money: Concept of Money, classification and functions of money, Classical approach to the demand for money - Quantity theory approach, Fisher's equation, Cambridge quantity theory, Keynes's liquidity preference approach, transaction, precautionary and speculative demand for money - aggregate demand for money; Derivation of LM curve.	10
V	Supply of Money: Component and determinants of money supply, high power money, money multiplier, Financial intermediation - a mechanistic model of bank deposit determination; A behavioral model of money supply determination, a demand determined money supply process; RBI approach to money supply, Monetary policy in India.	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Suggested Readings:

- Ackley,G.(1978), Macro Economics : Theory and Policy, Macmillan, New York.
- Blackhouse, R. and A. Salansi (Eds.) (2000) Macroeconomics and the Real World (2 Vols.), Oxford University Press, London.
- Branson, W.A. (1989), Macroeconomics : Theory and Policy, (3rd Edition), Harper and Row. New York.
- Dornbusch, R. and F. Stanley (1997), Macroeconomics, McGraw Hill, Inc, New York.
- Hall, R.E. and J.B. Taylor (1986), Macroeconomics, W.W. Norton, New York.
- Heijdra, B.J. and V.P. Fredericck (2001), Foundations of Modern Macroeconomics, Oxford University Press, New Delhi.

Programme/Class: M.A.	Year: First	Semester: I
Subject: ECONOMICS		
Course Code: ECOC103	**Course Title: Indian Economy**	**(Theory)**

Course Objectives: The objective of this course is to sharpen the analytical faculty of the student, by highlighting an integrated approach to the functioning aspects of the Indian economy, keeping in view the scope for alternative approaches. Such an analysis is essential because the Indian economy is a unique amalgam of alternative competing and often conflicting theories and a proper understanding of its working is imperative if the student is to comprehend the ramifications that underlie most of the observed phenomena in the Indian economic set-up. The emphasis of the course is on overall social, political and economic environment influencing policy decisions. To develop all these themes, the course is divided into specific units.

Credits: 5	Core
Max. Marks: 25+75 {Internal + External (Practical)}	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	Salient features of the Indian Economy, Basic Economic indicators and their Importance; Problems of resource mobilization and price stability. Planning: Objectives, approaches, priorities and problems	10
II	Growth and Composition of National Income; Contribution of different sectors & growth pattern; Poverty in India- concepts, incidence & extent of poverty, Measures to curb socio-economic inequalities; Concepts of Consumer Price Index (CPI) and Wholesale Price Index (WPI).	10
III	Population and Human Development: Indian Demographics; Education and Health – Financing (Private vs Public), New Education and Health Policies; Problem of Unemployment in India; Human Development- Concept and Indices – Human Development Index, Gender Development Indices; Hunger Index, Happiness Index; Sustainable Development Goals (SDGs); Environmental Policy of India.	
IV	Agriculture: Distribution of Landholdings and Land reforms; Technological aspects, Rural credit; Agricultural price policy; Rural development programmes in India; Strategies for agricultural development and sustainability of agriculture growth. Industry: Growth and pattern of industrialization; MSME sector; Productivity in industrial sector, Public Sector enterprises and their performance; Problem of sick units in India; Privatization and disinvestment.	10
V	Performance and Sectorial distribution - Energy & Power, Transport system, Tele-communication, IT-BPM services; Salient features of India's foreign trade; Trends in foreign trade in the recent past, Balance of payment.	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, etc.

Suggested Readings:

VK Puri, SK Misra, Bharat Garg. 2022. Indian Economy. Himalayan Publishing House.
Ramesh Singh. 2022. Indian Economy (14th Edition). McGraw Hill Publication.
Rajiv Kumar, Abhijit Sen Gupta. India and the Global Economy. Academic Foundation.
Shakar Acharya and Rakesh Mohan. 2012. India's Economy Performance and Challenges. Oxford India.
Uma Kapila. 2022. Indian Economy: Performance and Policies. Academic Foundation.
Rabindra N. Bhattacharya. 2020. Environmental Economics. Oxford India.
Arvind Pangariya. 2013. India: The Emerging Giant. Oxford University Press.
Government of India. 2004. Indian Vision 2020: The Report of the committee on India Vision 2020. Planning Commission.
Sanjaya Baru. 2022. Journey of a Nation: 75 years of Indian Economy.
Sriram Sriringam. 2022. Indian Economy. Pearson.

Additional Readings:

J. Bhagwati and Padma Desai. 1970. India Planning for Industrialization: Industrialization and Trade Policies Since 1951. Oxford University Press.
Pulapre Balakrishna. 2022. India's Economy From Nehru To Modi:: A Brief History. Permanent Black.

Programme/Class: M.A.	Year: First	Semester: I
Subject: ECONOMICS		
Course Code: ECOE104A	**Course Title: Mathematical Economics**	**(Theory)**

Course Objectives: The aim of the course is to equip the student with the fundamental understanding of mathematical & quantitative methods and their usage in economics. To learn the mathematical tools and concepts that aid in analyzing economic optimization. This course is designed for students who plan to do further higher level work in economic theory. Hence in this paper a student will be initiated into various economic concepts, which are amenable to mathematical treatment.

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

CO-1 have an understanding of the basic reasoning of Mathematical Economics and understand the uses of Mathematical Economics in consumption; production, cost theory of firm and distribution in an analytical way;

CO-2 a selection of basic mathematical tools that are used by economic theorists,

CO-3 acquire theoretical and practical knowledge of mathematical techniques used in the empirical analysis of economic relationships and ;

CO-4 develops mathematical models in economics for optimal managerial decisions to get employment.

Credits: 5	Elective
Max. Marks: 25+75 (Internal + External)	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	**Basic Mathematics** Elementary Concepts of algebra, trigonometry and analytical & coordinate geometry. Graphs of functions & shifting of graph.	10
II	**Matrix and Determinants** Determinants, Properties of determinant, Minors and Cofactors, Jacobian and Hessian determinants, Solution of simultaneous equations through Cramer's rule; Matrices: concept of matrix-their types, simple operations on matrices; Inverse matrices; Rank of matrix; Solving matrix equations with inverse; Eigen values and Eigen vectors. Introduction to input-output analysis.	10
III	**Differentiation and its Economic Applications** Differential Calculus: First order derivative and its application in Economics; Concepts of slope, elasticity of demand, marginal revenue, marginal cost and marginal product; Second order derivative and its applications in Economics; Point of inflexion, concavity and convexity of a curve, problem of maximization and minimization of certain economic variables. Partial Differentiation and its Applications in Economics; Young's Theorem, Constrained Optimization, Determination of Total Derivatives and its Application in Economics	10
IV	**Integration and its Economic Application** Rules of Indefinite: Integration by Substitution; Integration by parts. Definite Integration and its Applications: Investment and Cost functions, Area under a curve, Consumer surplus, Producer surplus and Present value.	10
V	**Linear Programming** Basic concept & Formulation of a linear programming problem-Its structure and variables; Nature of feasible, basic and optimal solution; Solution of a linear programming problem through graphical and simplex method; Concept of duality; Formulation of the dual of a programme.	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Suggested Readings:

1. Allen, R.G.D. (1974) Mathematical Analysis for Economists, Macmillan Press and ELBS. London.
2. Chiang, A. C. (1986) Fundamental Methods of Mathematical Economics, McGraw Hill, New York.
3. Yamane, Taro (1975) Mathematics for Economists, Prentice Hall of India, New Delhi.
4. Knut Sydsaeter & Peter J. Hammond (2007) Mathematics for Economic Analysis, Pearson Education, India
5. Monga, G. S. (1972) Mathematics and Statistics for Economists, Vikas Publishing House, New Delhi.
6. Hadley, g. (1962) Linear Programming, Addison Wesley Publishing co., Massachusetts.
7. Mehta and Madnani: Mathematics for Economists, New Delhi: Sultan Chand Company

Programme/Class: M.A.	Year: First	Semester: I
Subject: ECONOMICS		
Course Code: ECOE104B	**Course Title: Labour Economics**	**(Theory)**

Course Objectives: This course will develop an understanding among students regarding the issues pertaining to the labour market, wage theories, employment policies, trade unions and collective bargaining in the globalized economy.
Course outcomes: On successful completion of this course students will be able to:
CO-1 have an understanding of the basic concepts of labour economics;
CO-2 have an acquaintance of labour market, wage determination and industrial relation with special reference to India,
CO-3 critically evaluate labour problems of developing countries like India and policies;
CO-4 enhance the employment opportunities.

Credits: 5	Elective
Max. Marks: 25+75 {Internal + External (Practical)}	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	**Labour Markets**: Nature and characteristics of labour in India and its role in economic development; Paradigms of labour market analysis - Classical, neo-classical and dualistic economy; Demand and Supply for labour in in relation to economic growth; Mobility and productivity of labour; Globalization and labour.	10
II	**Employment:** Employment and development relationship - Poverty and unemployment in developing countries; Unemployment - Concept, Types, and Measurement, particularly in India; Impact of technological change and modernization on employment in organized private industry, Public sector and agricultural sector.	10
III	**Wage Determination**: Concepts of wage, minimum wage, living wage and fair wage; Classical, neo-classical and bargaining theories of wage determination; Discrimination in labour markets in various sectors - Rural, urban, organized, unorganized and in informal sectors; Non-wage component of labour remuneration; Productivity and wage relationship; Analysis of rigidity in labour markets; Bonus system and profit sharing.	10
IV	**Industrial Relations**: Theories of labour movement - Growth, pattern and structure of labour unions in India; Achievements of labour unions; Causes of industrial disputes and their settlement and prevention mechanism; Role of tripartism; Current trends in collective bargaining.	10
V	**State and Labours:** National wage policy; Wages and Wage Boards in India; Labour legislation in India; Indian labour laws and practices in relation to international labour standards. **Concept of Social Security of Labour:** Concept of social security and its evolution; Social assistance and social insurance; Review and appraisal of states policies with respect to social security and labour welfare in India; Labour market reforms.	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Suggested Readings:

- Datt,G. (1996), Bargaining Power, Wages and Employment : An Analysis of Agricultural Labour Markets in India, Sage Publications, New Delhi.
- Hajela, P.D. (1998), Labour Restructuring in India : A Critique of the New Economic Policies,Commonwealth Publishers, New Delhi.
- Jhabvata, R. and R.K. Subrahmanya (Eds.) (2000), The Unorganised Sector : Work Security and Social Protection, Sage Publications, New Delhi.
- Lester, R.A. (1964), Economics of Labour, (2nd Edition), Macmillan, New York.
- McConnell, C.R. and S.L. Brue (1986), Contemporary Labour Economics, McGraw-Hill, New York.
- Papola, T.S., P.P. Ghosh and A.N. Sharma (Eds.) (1993), Labour, Employment and Industrial Relations in India, B.R. Publishing Corporation, New Delhi.
- Rosenberg M.R. (1988), Labour Markets in Low Income Countries in Chenery, H.B. and T.N. Srinivasan, (Eds.) The

Programme/Class: M.A.	Year: First	Semester: I
Subject: ECONOMICS		
Course Code: ECOE104C	**Course Title: History of Economic Thought**	**(Theory)**

Course Objectives: This course is essential for a student who aspires for advanced training in economics. Contemporary economic science has evolved over many centuries. The evolution of economic ideas in each instance was as much a response to immediate economic problems and policy issues as much as it was a self-conscious attempt to refine earlier analysis by correcting mistakes and filling in the gaps in analysis. Economic ideas did not evolve in isolation, but were an integral and important part of the evolution of modern social thought.

Credits: 5	Elective
Max. Marks: 25+75 {Internal + External (Practical)}	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	Early Period: Economic thought of Plato and Aristotle- Doctrines of Just cost and Just price —Mercantilism: main characteristics; Thomas Mun- Physiocracy: natural order, primacy of agriculture, social classes, Tableau Economique, taxation.	10
II	The Classical System : Adam Smith- Division of labour, Theory of value and distribution; David Ricardo - Theory of value and distribution; T.R. Malthus- Theory of population and the theory of Glut; J. S. Mill - Laissez faire and protection; J. B. Say - The law of markets; Karl Marx- Theory of value; Theory of capitalist competition.	10
III	The Historical Schools: Subjectivism and Marginalism: H.H. Gossen; W.S. Jevons; G. Cassel, The Austrian School: K. Menger; Bohm-Bawerk. L. Walras: General equilibrium analysis.	10
IV	The Mathematical School: A. Cournot; F. V. Edgeworth; I.Fisher, The American contribution: J. B. Clark; A. Walker; J. A. Schumpeter.	10
V	Neo classicism and After: A. Marshall and his system of equilibrium, K. Wicksell & the Swedish School, Economics of welfare: A. C. Pigou, A. P. Learner, V. Pareto. J. M. Keynes; Post-Keynesian and Neo-Keynesian approaches, Neo-Walrasian approach to general equilibrium.	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Suggested Readings:

1. Fundamentals of Computers by Rajaraman V, Prentice Hall India Learning Private Limited; 5 edition (2010)
2. David Whiteley, E-Commerce: Strategy, Technologies and Applications, Tata McGraw Hill, NewDelhi.
3. Goel, Sushil, Computer Application to Business & E-Commerce, Natraj Publishing House,Karnal.
4. Lipschultz, M.M. and S. Lipschultz , Theory and Problems of Data Processing, Schum's OutlineSeries, McGraw Hill, New York.
5. Madan, Sushila, Information Technology, Taxman Allied Services, New Delhi.
6. P.T. Joseph, S.J. , E- Commerce : An Indian Perspective, PHI Learning , New Delhi.
7. Parameswaranm R. Computer Applications in Business, S. Chand and Company, New Delhi.

This course can opt as an elective/ value-added course by the students of the following subjects: Open to all

Suggested Continuous Evaluation Methods:
Assignment, Internal, Quiz, PPT presentation, External Examination etc.

Suggested equivalent online courses:
Suggestive digital platforms web links-ePG-Pathshala, IGNOU & UPRTOU online study material SVAYAM Portal http://heecontent.upsdc.gov.in/Home.aspx

Programme/Class: M.A.	Year: First	Semester: I
Subject: ECONOMICS		
Course Code: ECOME101	**Course Title: Basic Economics**	**(Theory)**

Course Objectives: This paper provides the basic understanding of Economics concepts to the students of other departments.

Credits: 4	Minor Elective (For Other Faculty students)
Max. Marks: 25+75 {Internal + External (Practical)}	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0

Unit	Topics	No. of Lectures = 40
I	Scope and Method: Nature of Economic Laws- Micro economics versus Macro Economics; Concept of margin; Cardinal versus Ordinal approach of Utility; Indifference curve analysis and its properties; Consumer Surplus, and Consumer's equilibrium. Demand Analysis: Demand function and law of demand; Concept of elasticity-price, cross and income elasticity of demand. Economic Systems- Capitalism, Socialism and Mixed economy; Problem of resource allocation.	10
II	Production: Production function, Combination of factors, Laws of production- Returns to scales, Law of variable proportions; Isoquant and its properties; Producer's equilibrium.	10
III	Nature of Costs and Markets: Cost functions- Short-run and long-run cost curves; Structure of Markets: Nature of perfect competition, monopoly and monopolistic competition; Equilibrium of firm.	10
IV	National Income Analysis: Concepts, Methods of measurement; Circular flow of income; Concept of inflation and employment; Sources of income – Central, State and Local Governments in India.	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Suggested Readings:

1. An Introduction to Positive Economics – R. G. Lipsey
2. Economics – Samuelson and Nordhaus
3. Modern Micro Economics – A. Koutsoyiannis
4. Principles of Micro Economics – Mankiw
5. Principles of Macro Economics – Mankiw
6. Advanced Economic Theory – H. L. Ahuja
7. Micro Economic Theory - Gould and Ferguson
8. Indian Economy - A. N. Agarwal

This course can opt as an elective/ value-added course by the students of the following subjects: Open to all

Suggested Continuous Evaluation Methods:
Assignment, Internal, Quiz, PPT presentation, External Examination etc.

Suggested equivalent online courses:
Suggestive digital platforms web links-ePG-Pathshala, IGNOU & UPRTOU online study material SVAYAM Portal http://heecontent.upsdc.gov.in/Home.aspx

Programme/Class: M.A.	Year: First	Semester: II
Subject: ECONOMICS		
Course Code: ECOC201	**Course Title: Advance Economic Theory**	**(Theory)**

Course Objectives: This course aims to introduce the students to know and understand the theoretical concepts of advanced economics. This course is to introduce students to the advanced theories economics.

Course outcomes: On successful completion of this course students will be able to understand advance topic of Economics.

Credits: 5	Core Compulsory
Max. Marks: 25+75 (Internal + External)	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	Advance theories of microeconomics - von Neumann–Morgenstern (VNM) utility theorem; limit pricing theory; Sale maximization theory, Baumol's sales revenue maximization, Behavioural theory of firm.	10
II	Theories of General Equilibrium - General Equilibrium - Partial and general equilibrium, Walrasian excess demand and input-output approaches to general equilibrium, existence, stability and uniqueness of equilibrium and general equilibrium, coalitions and monopolies; Production without consumption-one sector model, homogeneous functions, income distribution.	10
III	Classical and New Welfare Economics - The principle of Compensating variation, Hicksian and Slutsky's approaches to measurement of consumer's surplus, The concept and the conditions of Pareto Optimality, Pareto optimality in the General Equilibrium system. Compensation criteria, contributions of Barone, Hicks and Kaldor, Scitovsky's criterion. Social Optimum, Community indifference map, Samuelson's utility possibility curve, Bergson's Concept of Welfare and its Measurement, Social Welfare Function.	10
IV	Neo-classical, Keynesian synthesis, and Post- Keynesian Demand for Money - Neo-Classical and Keynesian views on interest; The IS-LM model; Extension of IS-LM model with Government sector; Extension of IS-LM models with labour market and flexible prices. Post-Keynesian approaches to demand for money - Patinkin and the Real Balance Effect, approaches of Baumol and Tobin; Friedman and the modern quantity theory; Crisis in Keynesian economics and the revival of monetarism.	10
V	New Classical Economics – Samuelson and Solow - the natural rate of unemployment hypothesis; Tobin's modified Philips curve; a broader view of new classical position, Adaptive expectations and rational expectations; Policies to control inflation.	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Suggested Readings:

- Gould & Lajear Micro Economics
- Richard A. Bilas Micro Economic Theory
- Paul, A. Samuelson Economics
- R. H. Lelftwich The Price system and Resource Allocation.
- A. Koutsoyiannis Modern Micro Economics
- Joseph E. Stiglitz Economics, W.W. Norton & Company, New York, London.
- Ackley,G.(1978), Macro Economics : Theory and Policy, Macmillan, New York.
- Blackhouse, R. and A. Salansi (Eds.) (2000) Macroeconomics and the Real World (2 Vols.), Oxford University Press, London.
- Branson, W.A. (1989), Macroeconomics : Theory and Policy, (3rd Edition), Harper and Row. New York.
- Dornbusch, R. and F. Stanley (1997), Macroeconomics, McGraw Hill, Inc, New York.
- Hall, R.E. and J.B. Taylor (1986), Macroeconomics, W.W. Norton, New York.

Programme/Class: M.A.	Year: First	Semester: II
Subject: ECONOMICS		
Course Code: ECOC202	**Course Title: Statistical Methods for Economic Analysis**	**(Theory)**

Course Objectives: The main objective of this paper is to train the students to use the techniques of statistical analysis, which are commonly applied to understand and analyse economic problems. The paper deals with simple tools and techniques, which will help a student in data collection, presentation, analysis and drawing inferences about various statistical hypotheses.

Credits: 5	Core Compulsory
Max. Marks: 25+75 (Internal + External)	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	**Correlation**- meaning , assumptions and limitations of simple correlation; methods of studying correlation- Scatter Diagram method and Graphic method, determination of correlation coefficient- Karl Pearson's method, Spearman's Rank correlation method, and Concurrent Deviation method; properties of correlation coefficients; probable error; partial and multiple correlation (applications only). **Regression**- meaning , assumptions and limitations of simple regression analysis; concept of the least squares and the lines of regression; standard error of estimates; partial and multiple regression (applications only).	10
II	**Index Number-** meaning and importance of index numbers, construction of index numbers, problems involved, Laspayer's, Pasche's and Fisher's index numbers; factor reversal and time reversal tests; circular test of consistency; fixed base and chain base index numbers; base shifting and splicing of index numbers. **Time Series**- meaning and components of time series, measurement of trend by moving average method and the method of least squares; curve fitting by mathematical equations.	10
III	**Elementary Sampling Theory-** basic concept of sampling; methods of sampling-random and non-random sampling; probability and non-probability sampling; simple random sampling, stratified random sampling, purposive sampling, convenience sampling.	10
IV	**Probability:** definition and importance, basic concepts of events: simple and compound events, mutually exclusive and mutually not exclusive events, dependent and independent events, complimentary events; Addition and Multiplication theorem; numerical problems based on the addition and multiplication theorem; concept of conditional probability and Baye's theorem, numerical problems based on the B mathematical expectations.	10
V	**Theoretical Frequency Distributions:** meaning of frequency distribution; observed and theoretical frequency distribution; probability and non-probability frequency distribution; Properties of Binomial, Poisson and Normal distributions; simple numerical problems based on Binomial, Poisson and Normal distributions; **Statistical Inference-**Tests of significance for Attributes; Tests of significance for large samples; Tests of significance for small samples-Problems based on 't', chi-square and z-tests; F-Test and Analysis of variance.	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Basic Reading List :

1. D. N. Elhance — Fundamentals of Statistics.
2. S. P. Gupta — Statistical Methods (Sultan Chand & sons)
3. Sukhatme &. Sukhatme — Sampling Theory of Survey with Applications, lowa State University Press, Ames.
4. Yule & Kendall — An Introduction to the Theory of Statistics.
5. A. L. Bowley- — Elements of Statistics.
6. Dixon and Massey — Introduction to Statistical Methods.

Programme/Class: M.A.	Year: First	Semester: II
Subject: ECONOMICS		
Course Code: ECOC203	**Course Title: Development Economics**	**(Theory)**

Course Objectives: This course aims to introduce the students to know and understand the theoretical concepts of economic development and theories of economic growth. This course is to introduce students to the theories and empirics of economic growth and development.

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

CO-1 understands current policy debates and contributes to policy making in an informed way.

CO-2 learns how to conduct independent research in these areas. Knowledge about development issues, both from a theoretical as well as empirical perspective.

CO-3 discuss the important models, theories and implications of the alternative approaches to growth and ;

CO-4 develops economic growth models in the area of real world to get employment opportunities.

Credits: 5	Core Compulsory
Max. Marks: 25+75 (Internal + External)	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	**Economic Development: Concept & Measurement** Salient features of underdeveloped, developing and developed economies; Economic growth vs. Economic development; Measurement of Economic growth & Development- Capabilities Approach of Amartya Sen; Poverty- types and measurement: Lorenz curve, poverty gap, Foster-Greer Thorbecke index, Human poverty index, MPI & Chennery Ahluwalia development index.	10
II	**Theories and Approaches of Development** Development Process; Theories of Development- Lewis' Theory of Unlimited Supply of Labour, Ranis-Fie Model; Leibenstein's Critical Minimum Effort Thesis; Nelson's Low Level Equilibrium Trap; Rosenstein Rodan's Theory of Big-Push; Myrdal's-Backwash Effects, Boeke's Dualism and Arrow's Learning by Doing.	10
III	**Theories of Economic Growth** Balanced and Unbalanced Economic Growth, Classical Theory of Economic Growth, Marx's Theory of Economic growth, Marx's Stages of Economic Growth, Rostow's Stages of Economic Growth;	10
IV	**Modern Theories of Economic Growth** Conceptual framework and methodology of modern growth theories; Harrod-Domar Growth model, Neo-classical Growth Theories- Solow and Meade; Cambridge Theories of Growth- Joan Robinson, Kaldor.	10
V	**Technological Progress and Economic Growth** Technological Progress embodied and disembodied; Neutral and Non-Neutral (Hicks and Harrod); Arrow's learning by doing approach to economic growth, total factor productivity and growth accounting; Optimal growth theory: A K Model, Ramsay Model.	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Suggested Readings:

1. Barro, R. J. and Sala-i-Martin, X. 2007. Economic Growth (2nd Edition). Prentice-Hall of India, New Delhi.
2. Ghatak, S. (1986), An Introduction to Development Economics, Allen and Unwin, London.
3. Gillis, M., D.H. Perkins, M. Romer and D.R. Snodgrass (1992), Economics of Development, (3rd Edition), W.W. Norton, New York.
4. Kindleberger, C.P. (1977), Economic Development, (3rd Edition), McGraw Hill, New York.
5. Meier, G.M. and J.E.Rauch (2005), Leading Issues in Economic Development, (8th Edition), Oxford University Press, New Delhi.
6. Herrick, B. and Kindleberger, C. P. 1984. Economic Development.(4th Edition). McGraw Hill Book Company

Programme/Class: M.A.	Year: Four	Semester: II
Subject: ECONOMICS		
Course Code: ECOE204A	**Course Title: Computer Application in Economics**	**(Theory)**

Course Objectives: This course will develop an interest among students regarding use of computer in Economics. The usage of statistical tools, software and preparation of data files will make the student industry ready.

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

CO-1 have an understanding of the basic uses of computer in economics;
CO-2 have an knowledge of statistical software & its uses in economics,
CO-3 critically evaluate economic problems of developing countries and ;
CO-4 use of statistical software for all economic problems and got a chance for employment in various industries.

Credits: 5	Elective
Max. Marks: 25+75 {Internal + External (Practical)}	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 2-0-3

Unit	Topics	No. of Lectures = 50
I	**Fundamentals of Computer** Introduction to Computers; Classification of Digital Computer, Meaning and Concept; Hardware, Software and Types of Software; Operating System Meaning and Functions; Memory – RAM and ROM; Input-Output Devices;	10
II	**Data Management** Concept of Data – Record and File – Types of Data – Data Entry – File handling and Operations like opening, appending and cascading – closing and attribute controls – Data Storage and Retrieval, Graphical Representation of Data; DBMS Definition including DDL and DML , Advantage and limitation of database system	10
III	**Introduction to MS Office & its Applications in Economics** MS-Word- Text Basics, Text Formatting and saving file, Sharing and Maintaining Document etc. and Working on MS-Power Point. MS-Excel- Summarizing and analysis of data; Descriptive Statistics (Mean, median, mode, standard deviation, Skewness); Comparison of means; Correlation and Regression analysis; Estimation of Growth Rates; Trends in Forecasting; Testing the significance of parameters.	10
IV	**Introduction to SPSS** Basics of Data Analysis – Data Entry in SPSS – Computing with SPSS – Preparation of Graphs with SPSS – Distribution Functions and Density Functions, Command description for SPSS – Reports, Descriptive – Statistics, Compare Means, Correlation Regression Models and Time Series Analysis.	10
V	**Introduction to STATA** Analysis of Data with STATA- Descriptive Statistics, Compare Means, Correlation Regression Models Time Series Analysis and Testing of hypothesis.	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Suggested Readings:

- Fundamentals of Computers by Rajaraman V, Prentice Hall India Learning Private Limited; 5 edition (2010)
- Goel, Sushil, Computer Application to Business & E-Commerce, Natraj Publishing House,Karnal.
- Lipschultz, M.M. and S. Lipschultz , Theory and Problems of Data Processing, Schum's OutlineSeries, McGraw Hill, New York.
- Parameswaranm R. Computer Applications in Business, S. Chand and Company, New Delhi.
- Book on MS-Excel
- Book on SPSS
- Book on STATA

Programme/Class: M.A.	Year: I	Semester: II
Subject: ECONOMICS		
Course Code: ECOE204B	**Course Title: Indian Economic Thoughts**	**(Theory)**

Course Objectives: This course will develop an interest among students regarding understanding of Indian Economic thoughts.

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

CO-1 familiar with the basic economic ideas of Mahatma Gandhi.

CO-2 familiar with modern economic thoughts after 19th century;

Credits: 5	Elective
Max. Marks: 25+75 (Internal + External)	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	Ancient Indian Economic Thought- Valluvar: The idea of wealth, factor of production, welfare state, public health and public finance, poverty & begging. Kautilya: The Idea of Welfare State, Taxation & Public Finance, Interest & Profit, Trade, Infrastructure, Agriculture, Wage Policy, Price Regulation,	10
II	Dadabbhai Naoroji: Theory of Economic Drain, National Income of India, Taxation, The idea of Poverty; M.G. Ranade: Method & Scope of Political Economy, Economic Backwardness of India, Opposition to Laissez Faire & Theory of Drain; G.K. Gokhale: Economic Ideas, Indian Finance & Surplus budget, Economic Condition of India, Advocacy of Policy of Protection and Criticism of Drain Theory.	10
III	Mahatma Gandhi: Village, Swadeshi, Place of Machine and Labour, Trusteeship, Cottage Industries; Economic Thoughts of Jawaharlal Nehru, Ekatma Manavvaad of Deen Dayal Upadhyaya; Socialism of Dr Ram Manohar Lohiya	10
IV	B.R. Ambedakar: Theory of Agriculture; Labour, Population; Insurance; Budget & Finance; Sociolism; Industralision; J.K. Mehta: Wantlessness, The idea of Representative Firm, The theory of Interest & Profit; Economic thoughts of Chaudhary Charan Singh.	10
V	Economic Ideas of V. K. R. V. Rao, Amartya Sen, Jagdish Bhagwati, Abhijeet Banerjee	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Suggested Readings:

1. Kapila Uma, Indian Economy: Performance and Policies, Academic Foundation
2. Kumar Sanjeev, Crop Diversification and Food Security in India, Mittal Publications
3. Uttar Pradesh State Development Report, Volume I & II, State Plan Division, Planning Commission, Government of India, 2014.
4. Agarwal M.K. Uttar Pradesh Mein Arthik Vikas, New Royal
5. Madan, Sushila, Information Technology, Taxman Allied Services, New Delhi.
6. UP Human Development Reports and UP-SDR-2022
7. Relevant UP Government Publications

This course can opt as an elective/ value-added course by the students of the following subjects: Open to all

Suggested Continuous Evaluation Methods:
Assignment, Internal, Quiz, PPT presentation, External Examination etc.

Suggested equivalent online courses:
Suggestive digital platforms web links-ePG-Pathshala, IGNOU & UPRTOU, online study material SVAYAM Portal, http://heecontent.upsdc.gov.in/Home.aspx

Programme/Class: M.A.	Year: Four	Semester: II
Subject: ECONOMICS		
Course Code: ECOE204C	**Course Title: Economy of Uttar Pradesh**	**(Theory)**

Course Objectives: This course will develop an interest among students regarding understanding of Uttar Pradesh Economy.

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

CO-1 familiar with the basic characteristics of Uttar Pradesh economy,
CO-2 familiar with the its potential on natural resources of the economy of Uttar Pradesh;
CO-3 Students should be familiar with the industrial development in Uttar Pradesh;
CO-4 develop an understanding about Uttar Pradesh and got a chance for employment in various sectors in UP.

Credits: 5	Elective
Max. Marks: 25+75 (Internal + External)	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	**Introduction** Overview of Uttar Pradesh Economy – Nature, Features, Demographic Profile, Status of Natural Resources, Major Factors affecting growth and development in Uttar Pradesh-Economic and non-economic factors.	10
II	**Patterns of Economic Growth in Uttar Pradesh** Growth pattern of Uttar Pradesh economy; Sectoral pattern of Growth; Economic growth in Uttar Pradesh and Indian Economy; Infrastructural development of Uttar Pradesh.	10
III	**Agricultural and Rural Development in UP** Pattern of land-holding and irrigation; production and productivity in agriculture, Farm mechanization, Crop diversification, agricultural credit, Agricultural policy and strategies in Uttar Pradesh, Rural Development in Uttar Pradesh; Labour migration	10
IV	**Industry and Service Sectors in UP** Industrial and service sector development in Uttar Pradesh. Major industries in Uttar Pradesh, Pattern of Industrial Development in Uttar Pradesh, Industrial Policy in Uttar Pradesh, Growth pattern of Services sector.	10
V	**Social Sector Development in Uttar Pradesh** Education, Health, Manpower, HDI, Status and progress of SDG in U.P.	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Suggested Readings:

1. Kapila Uma, Indian Economy: Performance and Policies, Academic Foundation
2. Kumar Sanjeev, Crop Diversification and Food Security in India, Mittal Publications
3. Uttar Pradesh State Development Report, Volume I & II, State Plan Division, Planning Commission, Government of India, 2014.
4. Agarwal M.K. Uttar Pradesh Mein Arthik Vikas, New Royal
5. Madan, Sushila, Information Technology, Taxman Allied Services, New Delhi.
6. UP Human Development Reports and UP-SDR-2022
7. Relevant UP Government Publications

This course can opt as an elective/ value-added course by the students of the following subjects: Open to all

Suggested Continuous Evaluation Methods:
Assignment, Internal, Quiz, PPT presentation, External Examination etc.

Programme/Class: M.A.	Year: Second	Semester: Third
Subject: ECONOMICS		
Course Code: ECOC301	**Course Title: Public Finance**	**(Theory)**

Course Objectives: The term 'Public Finance' has traditionally been applied to the package of those policies and operations which involve the use of tax and expenditure measures while budgetary policy is an important part to understand the basic problems of use of resources, distribution of income, etc. Role and functions of the Government in an economy have been changing with the passage of time. There are vast array of fiscal institutions — tax systems, expenditure programmes, budgetary procedures, stabilization instruments, debt issues, levels of government, etc. which raise a spectrum of issues arising from the operation of these institutions. Further, the existence of externalities, concern for adjustment in the distribution of income and wealth, require political processes for their solution in a manner which combines individual freedom and justice.

Credits: 5	Core Compulsory
Max. Marks: 25+75 (Internal + External)	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	**Introduction:** Nature and Scope of Public Finance; Positive vs. Normative Public Finance; Market Failure and Role of Government in the Economic Development- Public Goods, Private Goods and Merit Goods; Externalities and Public Goods; Theories of Optimal Allocation of Society's Resources; Recent Development in Public Goods Theory.	10
II	**Public Expenditure:** Objectives, Allocation, Distribution and Stabilization; Wagner's Law of Increasing State Activities; Peacock-Wiseman Hypothesis. The Pure theory of Public Expenditure. Effects of Public Expenditure on Production, Growth, Distribution and Stabilization; Zero Based Budgeting.	10
III	**Public Revenue:** Sources of Public Revenue; Canons of Taxation; Process of Taxation; Theory of Tax Incidence; Trade-off Between Equity and Efficiency; Distribution of Tax Burden-Benefit and Ability to Pay Approaches in taxation; Taxable capacity; Double taxation; Effects of taxation on Production, Growth, Distribution and Allocation of Resources.	10
IV	**Public Debt:** Causes of Borrowings; Taxes versus Loans; Sources of Public Debt and their Economic Implications; Burden of Public Debt; Redemption of Public Debt; Public Debt Management; Effects of Public Debt on Economic Growth. **Federal Finance:** Principles of Federal Finance; Tiebout Model and Citizen Mobility; Imbalances in Federal Finance (Vertical and Horizontal); Transfer of Resources from Centre to States to Local Bodies.	10
V	**Fiscal Policy:** Fiscal Policy for Stabilization- Automatic vs. Discretionary Stabilization; Alternative Measures of Resource Mobilization and their Impact on Growth, Distribution and Prices; Balanced Budget Multiplier; Compensatory Finance; Functional Finance.	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Basic Reading List:

1. R. A. Musgrave & Peggy B. Musgrave- Public Finance in Theory and Practice.
2. John Cullis & Philip Jones- Public Finance & Public Choice. OPU, New York.
3. Ulbrich, Holley- Public Finance in Theory & Practice, Thomson
4. Gruber, Jonathan- Public Finance and Public Policy, Worth
5. R. J. Chelliah- Fiscal Policy in underdeveloped countries
6. R. N. Bhargava- The Theory and Working of Union Finance in India
7. Janak Raj Gupta- Public Economics in India, Atlantic
8. M. M. Sury- Public Economics, New Century

Programme/Class: M.A.	Year: Second	Semester: Third
Subject: ECONOMICS		
Course Code: ECOC302	**Course Title: Research Methodology**	**(Theory)**

Course Objectives: This is a course for studying various methods for conducting social science research. It deals with various approaches, methods, tools and techniques. Further, it deals with basic knowledge on computer, data, and estimation of statistical tools by using software and analyzing the results of economic relationships, testing economic hypotheses and forecasting.

Course outcomes: By the end of the course, the student should be able:

• To become familiar with basic knowledge research methodology and sampling techniques.

• To become familiar with basic knowledge on computer, with statistical software, to draw distributive tables, graphs, trend lines.

• To estimate the parameters of regressions with the help of software and interpret

Credits: 5	Core Compulsory
Max. Marks: 25+75 (Internal + External)	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	Introduction to social science research: Scientific and Social Science Research- nature, objectives and limitations; Meaning of research in Economics: Different types of research. Research Methodology. Preparation of a research proposal and the formulation of research design, Methods and techniques of research. Differences among them, the logical frame work of investigation, analysis of historical records	10
II	Research Process, Research Design, Identification and conceptualization of a research problem, setting up objectives and hypotheses.	10
III	Data Collection and Processing: Meaning and importance of data; Methods of collecting primary and Secondary data; Sampling techniques-sample size, Sampling error and problems in Sampling; tools of data collection. Scheduled and questionnaires; Nature of field work, pilot study, sampling frame and sample selection, Database of the Indian Economy.	10
IV	Preparation for Analysis, Editing, Coding, Classification & Transcription of Data, Tabulation, construction of Frequency Table, Graphs/Charts/Diagrams. Statistical Analysis of Data: Descriptive statistics. Measures of Central Tendency, Dispersion, Relationship, Correlation and Regression. Inferential statistics: Techniques of Testing of Hypotheses (parametric and non-parametric), Null and Alternative Hypothesis, Type-I and Type-II errors	10
V	Report writing: Types of reports; Steps in report writing; Format of the research report; Principles of writing; Documentation; foot notes; use of tables and graphs, citations and references; Do's and Don'ts of research writing	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Suggested Readings:

1. Ghosh, B.N. : Scientific Methods and Social Research, Sterling Publishers Pvt. Ltd, New Delhi, 1982.
2. Goode William J. and Hatt, Paul, Methods in Social Research, McGraw Hill, New York.
3. Gopal M.H. : An Introduction to Research Procedure in Social Sciences, Asia Publishing House, Bombay, 1964.
4. Gupta S.P (1988) –Statistical Methods- Sultan Chand & Sons , Delhi.
5. Gupta, S. C. (1993), Fundamentals of Applied Statistics, S. Chand & Sons, New Delhi.
6. Hans Raj : Theory and Practice in Social Research, Surjeet Publication, New Delhi, 1979.
7. Kothari C.R, (1988) Research Methodology Method and Techniques, Wiley Eastern Limited ,New Delhi
8. Sadhu A.N. and Singh Amarjit : Research Methodology in Social Sciences, Himalaya Publishing House, Bombay,
9. Tandon B.C. : Research Methodology in Social Science, Chaitanya Publishing House, Allahabad, 1979.
10. Wilkinson T.S. and Bhandarkar P.L. : Methodology and Techniques of Social Research, Himalaya Publishing

Programme/Class: M.A.	Year: Second	Semester: Third
Subject: ECONOMICS		
Course Code: ECOE303B	**Course Title: Econometrics**	**(Theory)**

Course Objective: This course provides the theoretical underpinnings for conducting applied econometric studies. It provides the conceptual framework on which such analyses are based, supplemented by illustrative empirical applications.
Course Learning Outcomes: The ability to conduct empirical analyses and data analytics are increasingly valued in the job market. This course will enable students to understand why and how questions are to be framed and answered. It will also equip them to learn more advanced topics on their own.

Credits: 5	Core Compulsory
Max. Marks: 25+75 (Internal + External)	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	Definition and scope of Econometrics, Deterministic and Stochastic models. Econometric model and its stages, Meaning and assumptions of simple regression analysis; Single linear equation regression model (by OLS Method); Concept of an estimator and its desirable properties; Significance of estimators in the linear relationships	10
II	Multiple Regressions with two explanatory variables, Partial and Multiple Correlation coefficients, Estimation of the Regression Coefficients, Testing of Significance of Regression, Coefficients and Regression Model, R- square, Adjusted R- square, Akaike Information Criteria and Schwarz Criterion.	10
III	General Linear Regression Model- Estimation of Parameters, Mean and Variance of the Estimate, Illustration of OLS Estimates as Best, Linear and Unbiased	10
IV	Nature, Tests, Consequences and remedies of Problem of Multicollinearity, Auto correlation, Nature of the problem, Consequences of using OLS in the presence of Auto correlation, Detecting Auto-correlation-Graphical Method, Durbin-Watson 'd-statistic', Remedial measures. Heteroscadasticity- meaning, graphical presentation of the presence of Heteroscadasticity. Consequences of Heteroscadasticity, Detection and remedial measures of the problem.	10
V	Application of simple linear models: Production function; Estimation of Cobb-Douglas, CES, Translog and other form of Production Function; Estimation of Consumption & Investment functions, Theories of Consumption; Permanent Income Hypothesis, Absolute Income Hypothesis, Life Cycle Hypothesis Relative Income Hypothesis, Classical and Keynesian Income Functions	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Suggested Readings:

- Gujarati, D.N. (1995), Basic Econometrics (2nd Edition), McGraw Hill, New Delhi.
- Koutsoyiannis, A. (1997), Theory of Econometrics (2nd Edition), the Macmillan Press Ltd., London.
- Johnston, J. (1991), Econometric Methods, McGraw Hill Book Company, London.
- Maddala, G.S. (1993), Econometrics Methods and Applications, (2 Vol.), Alder shot, U.K.
- Krishna K.L. (1997), Econometrics Application in India, Oxford University Press, New Delhi.
- Kmenta, J. (1997), Elements o/Econometrics, University of Michigan Press, New York.
- o Madnani, G.M.K. (1999), Introduction o/Econometrics.

Programme/Class: M.A.	Year: Second	Semester: Third
Subject: ECONOMICS		
Course Code: ECOE303C	**Course Title: Agricultural Economics**	**(Theory)**

Course Objective: To provide detailed understanding regarding the issues in agricultural economics to those intending to specialize in this area. To familiarize students with policy issues that is relevant to agricultural economics and enables them to analyse these issues.

Credits: 5	Core Compulsory
Max. Marks: 25+75 (Internal + External)	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	Agriculture and Economic Development : Inter-relationship between Agriculture and Industry, Approaches to Agriculture Development- Schultz, Mellor, Boserup, Lewis and Ranis –Fei, Inter-Regional Disparities in growth of output and productivity in Indian agriculture.	10
II	Marketing Structure : Agricultural Marketing, E-NAM, Price Spread, Behaviour of agricultural Prices, Marketed and marketable Surplus, Terms of Trade between agriculture and Industry - their impact on agriculture and change since Independence, Price trends, Role of Subsidies, Agricultural Price Policy in India, Cobweb theorem.	10
III	Strategy of Agricultural growth and Technological Progress: Capital formation in Indian Agriculture, Public and Private investment, Type and Measurement of technical changes, Nature and Pattern of technical change, Agricultural production function, farm size, Measures of Farm Efficiency.	10
IV	Conventional farming to Sustainable farming, Approaches to Sustainable Agriculture, Growth and composition of output in agricultural and allied activities in India: Trends in overall agricultural growth as well as of Pulses, Food and Non-food item. Demand and supply of agricultural commodities including plantation and Horticultural Produce. Demand availability and Future prospects of livestock, Poultry and Fishery in India.	10
V	Current issues in Indian Agriculture, Pattern of change in Exports and imports of agricultural commodities, Composition of Exports and imports of agricultural commodities and recent trends, WTO, Agreement on Agriculture – Tarrification, AMS, Export subsidies, Market Access Clause, Safeguard Provisions, Sanitary and Phytosanitary Measures.	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Suggested Readings:

- Alag Y.K. Globaliosation and Agriculture Crisis in India, Deep and Deep Publications
- Bilgrami S. A.R. An Introduction to Agricultural Economics, Himalaya Publishing House
- Kumar. Sanjeev. The State of Indian Agriculture, Sage Publications
- Lekhi R.K., & Joginder Singh, Agricultural Economics, Kalyani Publishers
- Meier Gerald M. Leading Issues in Economic Development, Oxford University Press
- Mellor, John, Agricultural Development and Economic Transformation, Palgrave Macmillan
- S.R.Mehta: Sociology of Rural Development; Sage. Publications
- Sadhu A.N and Singh Amarjit, Fundamentals of Agricultural Economics, Himalaya Publication House

Programme/Class: M.A.	Year: Second	Semester: Third
Subject: ECONOMICS		
Course Code: ECOE304A	**Course Title: Rural Development**	**(Theory)**

Course Outcome: The Students will be able to

- Define the Agriculture, rural areas and rural families and principles of rural economic development
- Explain the types of agriculture to include, horticulture, dairying and allied rural activities
- Distinguish the rural poverty and land holdings
- Elucidate the Agricultural Finance and rural credits system and marketing system

Credits: 5	Core Compulsory
Max. Marks: 25+75 (Internal + External)	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	Principles of Rural Economic Development, Planning the Rural Development. Tools for Rural Economic Analysis,	10
II	Agriculture, Nature, Type of Agriculture, Subsistence, Commercial Agriculture, Rural Horticulture, Dairying, Land use – Land Holding, Land Reforms Marginal Lands.	10
III	Poverty, BPL families, Agricultural laborers and Social Security, Agricultural Finance – Need for Agricultural Finance, Sources of Agricultural Finance Kisan Credit card, the role of NABARD in Rural Development, Agricultural Marketing	10
IV	Agricultural policy and Rural Development, Agricultural pattern – Food crops, Commercial crops, National Agricultural policy, Agricultural prices policies trends in Agricultural prices, Causes for farmers suicide problems of Agricultural labourers.	10
V	Theories of Rural Development: Rostow's Stages of Growth; Lewis Theory of Development; Theory of Big Push; Marxian Concept of Development; Schultz's Transformation of Traditional Agriculture;	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Suggested Readings:

- Agricultural Development Policy: Concepts and Experiences – Narton R.D.
- Indian Agricultural Policy at the cross roads – S.S Acharya.
- Chamber, Robert, 2005, Ideas for Development, Earthscan from Routledge
- IDFC Rural Development Network, 2013, India Rural Development Report, 2012-13, Delhi: Orient Black Swan

Programme/Class: M.A.	Year: Second	Semester: Third
Subject: ECONOMICS		
Course Code: ECOE304B	**Course Title: Demography**	**(Theory)**

Course Objective: The main objective of this paper is to make the students aware of the importance of population in economic development and the various theories that explain the growth of population in a country. The paper also enlightens the students on the quantitative and the qualitative aspects and characteristics of the population through various demographic techniques. In recent times, gender characteristics of the population have acquired importance and these have also been included in the framework of study. Migration and urbanization are the characteristics of structural change taking place in a society. Their study is essential to understand the dynamics of this change. The paper exposes the students to sources of population and related characteristics as also to the rationale, need and evolution of population policy.

Credits: 5	Core Compulsory
Max. Marks: 25+75 (Internal + External)	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	Nature and Scope of Demography and Age-Sex Structure of Population - Meaning and scope of Demography; differences between Demography and Population Studies; Measures of population change; important sources of population data; levels and trends in population in developing and developed countries; population explosion; pattern of age and sex structure in developed and underdeveloped countries; Age-sex structure, social and regional distribution of population; Demographic effects of sex and age structure, economic and social implications; Age Pyramids, and population ageing.	10
II	Fertility and Nuptiality - Importance of the study of human fertility, different measurements of fertility, levels and trends of fertility in developed and underdeveloped countries; Factors affecting fertility, theories of fertilities; concept and measurement of nuptiality; and determinants and consequences of change in age at marriage.	10
III	Mortality and Life tables – Concept of mortality and morbidities and their measurements; levels and trends in child and adult mortality in developed and less developed countries; Sex and age pattern of mortality; factors of decline in mortality in recent past; Life table - Construction and uses; Concepts of stable stationary population; Methods of population projection.	10
IV	Population and Development - Components of population growth and their inter-dependence; Theories of population - Malthus, Optimum theory of population; Theory of demographic transition - Views of Medows, Enke and Simon. Population, economy and environment linkages - Population, health, nutrition productivity nexus; Population and human development issues; Education and fertility, Demography and household economic behaviour. Evolution of population policy in India - The shift in policy from population control to family welfare, to women empowerment; Family planning strategies and their outcomes; Reproductive health maternal nutrition and child health policies and new population policy.	10
V	**Migration and Urbanization -** Concepts and types of migration; its effect on population growth and pattern; factors affecting migration; theories of migration related to internal migration; Urbanization - Growth and distribution of rural-urban population in developed and under countries.	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Programme/Class: M.A.	Year: Second	Semester: Third
Subject: ECONOMICS		
Course Code: ECOE304C	**Course Title: Industrial Economics**	**(Theory)**

Course Objective: In the contemporary would with globalization and liberalization more and more attention is being given to industry. This course intends to provide knowledge to the students on the basis issues such as productivity, efficiency, capacity utilization and debates involved in the industrial development of India. The objective is to provide a through knowledge about the economics of industry in a cogent and analytical manner, particularly in the Indian context

Credits: 5	Core Compulsory
Max. Marks: 25+75 (Internal + External)	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	Industrialization and its importance; problems of industrialization in the developed and developing economies.	10
II	Location of Industry: Different theories of location; factors affecting location of an industry; localization and decentralization of industries; diversification and integration of industrial units.	10
III	Project Appraisal: Cost-benefit analysis; net present value and internal rate of return criteria.	10
IV	Industrial Finance: Types of finance-equity debentures, public deposits, loans from banks and institutional finance. The financial ratios and their analysis.	10
V	Indian Experience: Industrial policy; industrial progress under the Plans; growth of public enterprises; problems of management; efficiency and pricing in public enterprises; industrial finance; problems of small scale and cottage industries; growth of concentration and monopoly; multinationals; industrial sickness; industrial relations; workers' participation in management.	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Suggested Readings:

- S. C. Kuchhal The Industrial Economy of India.
- B. N. Dutta Economics of Industrialization.
- J. S. Ba in Industrial Organizations
- Alak Ghosh Indian Economy-Its Nature and Problems
- C. N. Vakil (ed.) Industrial Development of India.
- J. N. Bhagwati & Planning for Industrialization.
- R. R. Barthwala Industrial Economics.
- P. J. Devine, et al. An Introduction to Industrial Economics.
- L. C. Gupta the Changing Structure of Institutional Finance in India.
- Dalip S. Swamy Multinational Corporations and the World Economy.
- V. B. Singh Multinational Corporations and India.

Programme/Class: M.A.	Year: Second	Semester: IV
Subject: ECONOMICS		
Course Code: ECOE401	**Course Title: International Economics**	**(Theory)**

Course Objective: The course provides a deep understating about the broad principles and theories, which tend to govern the free flow of trade in goods, services and capital—both short-term and long-term—at the global level. Besides, preparing the students about the relevance and limitations of these principles, the contents of the paper spread over different modules, lay stress on the theory and nature of the subject which, in turn, will greatly help them to examine the impact of the trade policies followed both at the national and international levels as also their welfare implications at macro level and the distribution of gains from trade to North and South with particular reference to India. The study of the paper under the present era of globalization will train the students about the likely consequences on income, employment and social standards and possible policy solutions as the world will move into the 21st century.

Credits: 5	Core Compulsory
Max. Marks: 25+75 (Internal + External)	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	International Trade: Interregional and International trade, International trade and growth, Production Possibility Curve, Community Indifference Curves, Offer Curves.	10
II	Absolute and Comparative Advantage, Theory of comparative Cost Advantage, Theory in terms of Opportunity Costs, The Hechscher-Ohlin Theory, The Leontief's paradox, The Rybczynski Theorem, Trade and Impercfect Competition.	10
III	Reciprocal Demand, Terms of Trade, Gains from Trade, Factors affecting terms of trade. Terms of Trade and Economic Development, Singer and Prebisch thinking on terms of trade and underdeveloped economies.	10
IV	(a) Determination of rate of exchange under conditions of inconvertible paper currencies-Purchasing power parity and balance of payment theories. Traditional, Absorption and monetary approaches for adjustment in the balance of payments, Foreign Trade Multiplier, Fixed versus Flexible exchange rates; fluctuations in exchange rates-causes and consequences. (b) International Reserves, Optimum Currency Areas Theory (Mundell & Magnifco) and impact in the developed and developing countries.	10
V	Free trade versus Protection. Theory of tariff: effects of tariff in terms of partial equilibrium and general equilibrium approaches. Concepts of effective tariff and optimum tariff. Quotas: effects of quotas, dumping, State trading. A general theory of customs union. Tariff versus quotas.	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Suggested Readings:

- Charles P. Kindleberger International Economics
- Bo Sodersten International Economics
- P. T. Ellsworth The International Economy
- Wesserman & Hultman Modern International Economics.
- H. G. Johnson International Trade and Economic Growth
- H. G. Mannur International Economics
- M. C. Vaish and Sudama Singh International Economics.
- Pilbeam, Keith (1998) International Finance, Palgrave.

Programme/Class: M.A.	Year: Second	Semester: IV
Subject: ECONOMICS		
Course Code: ECOE402A	**Course Title: Indian Public Finance**	**(Theory)**

Course Objective: This paper combines a thorough understanding of fiscal institutions with a careful analysis of the issues which underline budgetary policies in general and Indian experience in particular.

Credits: 5	Core Compulsory
Max. Marks: 25+75 (Internal + External)	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	**Public Expenditure:** Expenditure on revenue account and capital account; Development and non-development expenditure; Plan and non-plan expenditure; Trends of government expenditure in India; Expenditure of State Governments; Reforms in expenditure budgeting (programmme and performance budgeting); zero based budgeting; Fiscal Responsibility and Budget Management Act 2003 (key features).	10
II	**Taxation: Direct and Indirect Taxes;** The problems of tax compliance and tax evasion; Sufficiency Issue; Major taxes of central government; Major taxes of state government; Reform in direct taxes- Direct Tax Code (DTC); Reform in indirect taxes- Goods and Services Tax (GST); Major trends of tax revenue of the Centre and State governments; Indian tax system: salient characteristics; The effect of unaccounted money on social and economic system.	10
III	**Deficit Financing:** Why deficit financing, Advantages and risk of deficit financing, various concepts of deficits, Modes of deficit financing; Deficit financing in India-present policy; Public Debt Management in India; Recent fiscal policy stance of the Government of India.	10
IV	**Local Finance in India:** Local bodies in India; Powers of Municipal Corporation; Functions of municipal corporations; Powers and functions of Village Panchayats, Panchayat Samitis and Zila Parishads; State Finance Commissions and Local Finance; Critical assessment of local finance; Fiscal decentralization-73rd and 74th Constitutional Amendment Acts.	10
V	**Indian Federal Finance:** Federal financial structure after Independence, Division of functions and resources between Centre and States; Financial imbalance; Mechanism of financial adjustments; Gadgil Formula; Pranab Formula; Finance Commissions (FCs) and their recommendations (last 3 FCs); Review of Centre-State financial relations in India.	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Suggested Readings:

- Bagchi, A. (2006) 'Readings in Public Finance', Oxford University Press.
- Srivastava, D.K. (ed.) (2000) 'Fiscal Federalism in India: Contemporary challenges'; NIPFP, New Delhi.
- Sury, M.M. (1998) 'Fiscal Federalism in India', Indian Tax Institute, Delhi.
- Sury, M.M. (ed.) (2008) 'Taxation in India: 1925 to 2007', New Century, Delhi.
- Hajela, T.N. (2009) 'Public Finance', Ane Books Pvt. Ltd., New Delhi.
- Srivastava, D.K. (ed.) (2004) 'State Level Fiscal Reforms in India, vol. I & vol. II, Deep & Deep Publications, New Delhi.
- Sudipto Mundle (ed.) 'Public Finance', Oxford University Press, New Delhi.
- Vital, B.P.R. and Sastry, M.L. (2001) 'Fiscal Federatism in India', Oxford University Press, New Delhi.

Programme/Class: M.A.	Year: Second	Semester: IV
Subject: ECONOMICS		
Course Code: ECOE403B	**Course Title: Applied Econometrics**	**(Theory)**

Course Objective: This course provides the theoretical underpinnings for conducting applied econometric studies. It provides the conceptual framework on which such analyses are based, supplemented by illustrative empirical applications.

Credits: 5	Core Compulsory
Max. Marks: 25+75 (Internal + External)	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	Consumption functions – estimation of demand functions – Engel functions – functional forms viz. linear, double-log, semi-log, quadratic, log-inverse functions – computation of price and income elasticities	10
II	Absolute and Comparative Advantage, Theory of comparative Cost Advantage, : Production function – estimation of production functions viz. Cob-Douglas, CES, Translog, frontier functions – estimation of cost, profit and supply response functions.	10
III	Dynamic econometric models – Kyock, adaptive expectation and partial adjustment, Almon distributed lag models – panel models.	10
IV	(Qualitative response models – estimation of LPM, probit, logit and tobit models.	10
V	Simultaneous regression models – indirect least squares, two-stage least Squares – instrumental variable methods.	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Suggested Readings:

- D.N. Gujarathi: Basic Econometrics, Tata – McGraw Hill.
- A.Deaton and John Muellbauer: Economics and Consumer Behaviour, Cambridge University Press,
- Julia Hebden: Applications of Econometrics, Heritage Publishers.
- R.F.Wynn and K. Holden: An Introduction to Applied Analysis, Macmillan Press.
- M.Upender: Applied Econometrics, Vrinda Publications.

Programme/Class: M.A.	Year: Second	Semester: IV
Subject: ECONOMICS		
Course Code: ECOE404A	**Course Title: Environmental Economics**	**(Theory)**

Course Objective: This course is meant to provide some insights into the application of economic theory in the design and implementation of public policy related to the management of environment and social sectors. The course finds roots in welfare economics, national income accounting, macroeconomic policies and trade and development. Modules incorporated in this paper are devoted to issues of environmental economics, environmental and social services and the problem of valuation of these services, and designing of instruments and institutions for the management of environment. The models of optimal use of natural resources, macroeconomic issues, sustainable development, environmental resource problems in India and the economics of health and education constitute the other areas of the modules of this paper.

Credits: 5	Core Compulsory
Max. Marks: 25+75 (Internal + External)	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	**Welfare Economics, Social Sectors and Environment:** Pareto optimality and competitive equilibrium; Fundamental theorems of welfare economics; Externalities and market inefficiency—externalities as missing markets; property rights and externalities, non-convexities and externalities; Pareto optimal provision of public goods—Lindahl's equilibrium, preference revelation problem and impure and mixed public goods, common property resources. Introduction to Kuznet Curve.	10
II	**Measurement of Environmental Values:** Use values, Option values and non-use values; Valuation methods—Methods based on observed market behaviour; Hedonic property values and household production models (travel cost method and household health production function), Methods based on response to hypothetical markets, contingent valuation methods.	10
III	**The Theory of Environmental Policy:** Environmental externalities—Pigouvian taxes and subsidies, marketable pollution permits and mixed instruments (the charges and standards approach), Coase's bargaining solution and collective action; informal regulation and the new model of pollution control, Monitoring and enforcement of environmental regulation, Environmental institutions and grass root movements; Global environmental externalities and climatic change—Tradable pollution permits and international carbon tax, Trade and environment in WTO regime. Introduction to Kyoto Protocol.	10
IV	**Economics of Natural Resource Management and Sustainable Development**: Theories of optimal use of exhaustible and renewable resources; Environmental and development trade off and the concept of sustainable development; Integrated environmental and economic accounting and the measurement of environmentally corrected GDP; Macroeconomic policies and environment.	10
V	**Environmental and Natural Resource Problems in India** : Mechanism for environment regulation in India; Environmental laws and their implementation; Policy instruments for controlling water and air pollution and forestry policy; People's participation in the management of common and forest lands; The institutions of joint forest management and the joint protected area management; Social forestry — rationale and benefits.	10

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ assignments, Field visits., internships, etc.

Programme/Class: M.A.	Year: Second	Semester: IV
Subject: ECONOMICS		
Course Code: ECOE404C	**Course Title: Economics of Insurance**	**(Theory)**

Course Objective: The vital role of insurance in the task of risk-bearing and risk-elimination in the economic affairs has not been appreciated adequately in our country. Given that the element of risk or uncertainty is a universal and fundamental phenomenon in our economic life, the importance of insurance as a means of reducing uncertainty and risk in regard to personal and business activities cannot be overemphasized. The role of insurance sector in mobilizing a country's saving for channeling them into capital formation and thus contribute to a country's economic development is also documented. There is a wide spread recognition that insurance, particularly life insurance, is a prominent segment of applied economics. Insurance industry is an important constituent of financial services industry in India and is a major investment institution and prominent player in the capital market. However, in our country, study of the subject of insurance has largely remained neglected. With the opening of the insurance sector for private Indians and foreign players, the interest in the subject has been kindled. This course on Insurance Economics attempts to give a fairly comprehensive view of the subject to the postgraduate students in Economics and pave the way for possible future expansion of the teaching of an important branch of economics.

Credits: 5	Core Compulsory
Max. Marks: 25+75 (Internal + External)	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures = 50
I	Introduction : Economic security; Human quest for economic security through time; Exposure to losses; Role of insurance; Definition of insurance; Risk pooling and risk transfer; Economic and legal perspectives, Social vs. private insurance; Life vs. nonlife insurance; Classification of life, health and general insurance policies.	10
II	Risk and Risk Management : Fundamentals of uncertainty and risk; Pure risk and speculative risk; Expected utility and decision making under uncertainty; Expected utility and the demand for insurance; Moral hazard and insurance demand; Concept of risk management; Essentials of risk management; Elements of risk management—Risk assessment; Risk control and risk financing.	10
III	Insurance and Economic Development : Risk management and insurance in economic development, Insurance institutions as financial intermediaries; Insurance institutions as investment institutions; Insurance institutions in Indian capital market; Regulations governing investments of insurance institutions in India; IRDA rules in this regard.	10
IV	(a) Essentials of Life and Health Insurance : Fundamentals of life and health insurance; Functions of life and health insurance; Selection and classification of risks; Basics of premium construction; Valuation and distribution of surplus; Individual health insurance; Uses, Types of evaluation; Principles of underwriting of life and health insurance; Group insurance and superannuation (pension) schemes; Set-up and management of insurance companies. (b) Essentials of General Insurance : Definition of general insurance; Types of general insurance; Importance of general insurance; Importance of general insurance in a country's economic development; Concept of short-term risk; Fundamentals of the following concepts — Common law, Equity, Proposal/Accidence, Indemnity, Insurable interest, Contribution subrogation, Representation; Utmost good faith, Material fact, Physical hazard, Moral hazard; Policy endorsements conditions/warranties; Selection of risks; Inspection of risks; Rating and calculation of premiums; Tariffs and non-tariffs; Marketing of general insurance; Technology development and general insurance.	10

Programme/Class: M.A.	Year: Second	Semester: III
Subject: ECONOMICS		
Course Code: ECOR401	**Course Title: Research Project**	**(Practical)**

Course Objectives with Outcome: The objective of the course is to make the students learn the skills of formulation of research problem, objectives, hypotheses and also the skills of data collection, analysis and interpretation. This course is directly related to Ability Enhancement of students.

Credits: 4	Core (Research)
Max. Marks: 100 (Viva-Voce on Project Report)	Min. Passing Marks: 40

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

General Outlines

- Each student has to submit a research project under the supervision of a faculty member assigned by the departmental committee.
- Standard norms for the preparation of a research project report must be followed – introduction, brief background, relevance of the topic, literature review, problem statement, objectives, hypotheses, sample design, data nature and sources, tools and techniques of data collection, data presentation, analysis, and interpretation, findings and conclusion.
- The format for the outcomes of project report may be reported as per the following:

  Introduction & Review of Literature

  Research Methodology

  Conceptual & Theoretical Description

  Analysis and Interpretations

  Conclusion, Suggestions & Scope for further research

  References, Annexure, etc.
- The project report outcomes should be evaluated both in the form of report submitted and viva-voce examination by the board of examiners.
- This is to be evaluated as 'Satisfactory (S)' or 'Unsatisfactory (US)'.

Suggested Continuous Evaluation Methods:
Assignment, Report, PPT presentation, and Viva-voce

DEPARTMENT OF PHYSICAL EDUCATION & SPORTS

Program Outcome	Curriculum of Physical Education and Sports (Qualifying course) is a compulsory paper for undergraduate level students. This paper is required for all students of B. Sc. and B.Com. to instill the spirit of completeness. Students to make them physically activity to developed healthy mind and body**.**
Program Specific Outcome:	Students have to complete theory and practical exam in each graduation course year. Theory and practical have been in given same weights in exams. ➢ Students learn rules and regulations, skills, techniques and ground measurement of sports. ➢ Students become aware about the career opportunity available in sports. ➢ To make students aware about regular signatory body doping rules. ➢ To help students to learn competitiveness, team spirit and lead a healthy life. ➢ Beside sports activity students are also trained for yoga. This is very helpful in mental and physical health.

DEPARTMENT OF COMPUTER SCIENCE

B.Sc (Computer Science)

Programme specific Outcome	Ability to apply the knowledge gained from computer science course in particular to identify, formulate and solve real life complex engineering problems faced in industries and/or during research work with due consideration for the public health and safety, in the context of cultural, societal, and environmental situations. Ability to provide socially acceptable technical application of modern and appropriate techniques for sustainable development relevant to professional engineering practice. Ability to apply the knowledge of ethical and management principles required to work in a team as well as to lead a team.
Department of Computer Science	
Programme Outcome	An ability to apply knowledge of computing and mathematics. An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution. An ability to design, implements, and evaluate a computer-based system, process, component, or program to meet desired needs. An ability to function effectively on teams to accomplish a common goal. An understanding of professional, ethical, legal, security and social issues and responsibilities. An ability to communicate effectively with a wide range of audiences. An ability to analyze the local and global impact of computing on individuals, organizations, and society. Recognition of the need for and an ability to engage in continuing professional development. An ability to apply mathematical foundations, algorithmic principles, and computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices. An ability to apply design and development principles in the construction of software system of varying complexity.

Course	Course Out comes
English Language & Profession Communication I	To inculcate knowledge of English and professional communication.
Applied Mathematics I	On successful completion of this subject the students should have knowledge of matrices, differential calculus, multiple integrals and vector calculus.
Applied Physics I	On successful completion of this subject the students should have knowledge one digital circuits and various components in physics. To understand polarization, spiral theory of etc.
Computer fundamental,MS Window and MS Office Tools	To inculcate knowledge of computer fundamentals and understand the basic concept and the usage of internet, mail creation, resume preparation, develop excel sheets, develop ppts, etc.
English language professional Communication II	To inculcate knowledge of English and professional communication and Personality development.
Applied Mathematics-II	To inculcate knowledge on mathematics using Laplace transform, Fourier series, etc.
Basic Electronics	On successful completion of this subject the students should have knowledge of basic electronics.
Programming in C	On successful completion of this subject the students have the programming ability in C language.
Discrete Structures	To inculcate knowledge of sets, function and relation. To understand propositional logic, combinatorics & Graphs.
Switching theory & logic design	To understand logic circuits, gate delay, fault delection memories.
. Date structure using C	Enable the students to understand the abstract data types stack,queue,dequeue,and list.To be able to implement the Stack,queue,and dequeue.
Computer OrientedNumerical Techniques	To inculcate knowledge of algebra & transcendental equation interpolation
Computer Organization	To understand register transfer language, control design, processer design, input/output organization and memory organization.
OOP through C++	To inculcate knowledge of Object Oriented Programming Concept and programming in C++.
Database Management System	To inculcate knowledge on DBMS concept & introduction to SQL.
System software	Enable the students to get sufficient knowledge on various system resources to understand language processor, assembler and compiler.
Web designing with Java programming	To inculcate knowledge on Java Programming concepts. To understand the concepts in web design.
System analysis and design	To inculcate knowledge of system requirements, functional and technical requirements. To understand the scope of object oriented requirements specification and analysis and e
Computer Networks	To inculcate knowledge on networking concepts and technologies like wireless , broadband and Bluetooth.

DEPARTMENT OF B.Ed.

Programme Outcome	The programme titled B.Ed is intended to breed the following benefits to students. • Provide basic knowledge regarding teaching-learning process. • Basic knowledge regarding education system. • To inculcate knowledge to understand the problems of students. • Acquire the knowledge of education in different periods like ancient.
Programme Specific-	• Understand basic concept and ideas of educational theory. • Build understanding and perspective on the nature of the learner, diversity and learning. • Develop understanding about teaching, pedagogy, school management