Chaudhary Charan Singh University, Meerut

Syllabus of the Subject:

Physics

For First Three Years of Under-Graduate (UG) Programme

(As per guidelines of Common Minimum Syllabus prepared by U.P. Government according to the National Education Policy-2020 w.e.f. the session 2021-2022)

(For both University Campus and Colleges)

Members of the Board of Studies:

S. No.	Name	Signature
1.	Prof. M.K. Gupta, Dean, Science faculty	
2.	Prof. Beer Pal Singh, Convener-I	
3.	Prof. Anil Kumar Malik, Member	
4.	Dr. Rekha Sharma, Convener-II	
5.	Dr. S K Sharma, Member	
6.	Dr. Garima Jain, Member	
7.	Prof. L P Purohit, External Expert	
8.	Prof. Hitendra K Malik, External Expert	
9.	Prof. Lokendra Kumar, External Expert	
10.	Dr. Mahesh Kumar Sharma, Principal Scientist, NPL Delhi	
11.	Dr. B K Tyagi, Rtd. Principal	

SUBJECT: PHYSICS

Semester-wise Titles of the Papers in B.Sc. (Physics)

Year	Sem.	Course code	Paper Title	Theory/ Practical	Credits
First Year	I	B010101T	Mathematical Physics & Newtonian Mechanics	Theory	04
		B010102P	Mechanical Properties of Matter	Practical	02
	II	B010201T	Thermal Physics & Semiconductor Devices	Theory	04
		B010202P	Thermal Properties of Matter & Electronic Circuits	Practical	02
Second Year	III	B010301T	Electromagnetic Theory & Modern Optics	Theory	04
		B010302P	Demonstrative Aspects of Electricity & Magnetism	Practical	02
	IV	B010401T	Perspectives of Modern Physics & Basic Electronics	Theory	04
		B010402P	Basic Electronics Instrumentation	Practical	02
Third Year	V	B010501T	Classical & Statistical Mechanics	Theory	04
		B010502T	Quantum Mechanics & Spectroscopy	Theory	04
		B010503P	Demonstrative Aspects of Optics & Lasers	Practical	02
	VI	B010601T	Solid State & Nuclear Physics	Theory	04
		B010602T	Analog & Digital Principles & Applications	Theory	04
		B010603P	Analog & Digital Circuits	Practical	02

SEMESTER-WISE PAPER TITLES WITH DETAILS					
YEAR	**SEME-STER**	**PAPER**	**PAPER TITLE**	**PREREQUISITE For Paper**	**ELECTIVE For Major Subjects**
CERTIFICATE IN BASIC PHYSICS & SEMICONDUCTOR DEVICES					
FIRST YEAR	**SEMESTER I**	Theory Paper-1	Mathematical Physics & Newtonian Mechanics	Physics in 12th / Mathematics in 12th	YES Open to all
		Practical Paper	Mechanical Properties of Matter	Opted / Passed Sem I, Th Paper-1	YES Bota./Chem./Comp. Sc./ Math./Stat./Zool.
	SEMESTER II	Theory Paper-1	Thermal Physics & Semiconductor Devices	Physics in 12th / Chemistry in 12th	YES Open to all
		Practical Paper	Thermal Properties of Matter & Electronic Circuits	Opted / Passed Sem II, Th Paper-1	YES Bota./Chem./Comp. Sc./ Math./Stat./Zool.
DIPLOMA IN APPLIED PHYSICS WITH ELECTRONICS					
SECOND YEAR	**SEMESTER III**	Theory Paper-1	Electromagnetic Theory & Modern Optics	Passed Sem I, Th Paper-1	YES Open to all
		Practical Paper	Demonstrative Aspects of Electricity & Magnetism	Opted / Passed Sem III, Th Paper-1	YES Bota./Chem./Comp. Sc./ Math./Stat./Zool.
	SEMESTER IV	Theory Paper-1	Perspectives of Modern Physics & Basic Electronics	Passed Sem I, Th Paper-1	YES Open to all
		Practical Paper	Basic Electronics Instrumentation	Opted / Passed Sem IV, Th Paper-1	YES Bota./Chem./Comp. Sc./ Math./Stat./Zool.
DEGREE IN BACHELOR OF SCIENCE					
THIRD YEAR	**SEMESTER V**	Theory Paper-1	Classical & Statistical Mechanics	Passed Sem I, Th Paper-1	YES Chem./Comp. Sc./Math./Stat.
		Theory Paper-2	Quantum Mechanics & Spectroscopy	Passed Sem IV, Th Paper-1	YES Chem./Comp. Sc./Math./Stat.
		Practical Paper	Demonstrative Aspects of Optics & Lasers	Passed Sem III, Th Paper-1	YES Chem./Comp. Sc./Math./Stat.
	SEMESTER VI	Theory Paper-1	Solid State & Nuclear Physics	Passed Sem V, Th Paper-2	YES Chem./Comp. Sc./Math./Stat.
		Theory Paper-2	Analog & Digital Principles & Applications	Passed Sem IV, Th Paper-1	YES Open to all
		Practical Paper	Analog & Digital Circuits	Opted / Passed Sem VI, Th Paper-2	YES Chem./Comp. Sc./Math./Stat.

::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.*

::List of All Papers in All Six Semesters::

Programme	Year	Sem.	Course title		Credits	Teaching Hours
Certificate in basic Physics & Semiconductor Devices	**I**	**First**	Theory (B010101T) Mathematical Physics & Newtonian Mechanics	**Part A:** Basic Mathematical Physics **Part B:** Newtonian Mechanics & Wave Motion	04	60
			Practical (B010102P) Mechanical Properties of Matter		02	60
		Second	Theory(B010201T) Thermal Physics & Semiconductor Devices	**Part A:** Thermodynamics & Kinetic Theory of Gases **Part B:** Circuit Fundamentals & Semiconductor Devices	04	60
			Practical(B010202P) Thermal Properties of Matter & Electronic Circuits		02	60
Diploma in Applied Physics with Electronics	**II**	**Third**	Theory(B010301T) Electromagnetic Theory & Modern Optics	**Part A:** Electromagnetic Theory **Part B:** Physical Optics & Lasers	04	60
			Practical (B010302P) Demonstrative Aspects of Electricity & Magnetism		02	60
		Fourth	Theory(B010401T) Perspectives of Modern Physics & Basic Electronics	**Part A:** Perspectives of Modern Physics **Part B:** Basic Electronics & Introduction to Fiber Optics	04	60
			Practical (B010402P) Basic Electronics Instrumentation		02	60
Degree in Bachelor of Science	**III**	**Fifth**	Theory(B010501T) Classical & Statistical Mechanics	**Part A:** Introduction to Classical Mechanics **Part B:** Introduction to Statistical Mechanics	04	60
			Theory(B010502T) Quantum Mechanics & Spectroscopy	**Part A:** Introduction to Quantum Mechanics **Part B:** Introduction to Spectroscopy	04	60
			Practical (B010503P) Demonstrative Aspects of Optics & Lasers		02	60
		Sixth	Theory(B010601T) Solid State & Nuclear Physics	**Part A:** Introduction to Solid State Physics **Part B:** Introduction to Nuclear Physics	04	60
			Theory(B010602T) Analog & Digital Principles & Applications	**Part A:** Analog Electronic Circuits **Part B:** Digital Electronics	04	60
			Practical (B010603P) Analog & Digital Circuits		02	60

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

PART B: Newtonian Mechanics & Wave Motion		
V	**Dynamics of a System of Particles:** Review of historical development of mechanics up to Newton. Background, statement and critical analysis of Newton's axioms of motion. Dynamics of a system of particles, centre of mass motion, and conservation laws & their deductions. Rotating frames of reference.	8
VI	**Dynamics of a Rigid Body:** Angular momentum, Torque, Rotational energy and the inertia tensor. Rotational inertia for simple bodies (ring, disk, rod, solid and hollow sphere, solid and hollow cylinder, rectangular lamina). The combined translational and rotational motion of a rigid body on horizontal and inclined planes. Elasticity, relations between elastic constants, bending of beam and torsion of cylinder.	8
VII	**Motion of Planets & Satellites:** Two particle central force problem, reduced mass, relative and centre of mass motion. Newton's law of gravitation, gravitational field and gravitational potential. Kepler's laws of planetary motion and their deductions. Motions of geo-synchronous & geo-stationary satellites and basic idea of Global Positioning System (GPS).	7
VIII	**Wave Motion:** Differential equation of simple harmonic motion and its solution, use of complex notation, damped and forced oscillations, Quality factor. Composition of simple harmonic motion, Lissajous figures. Differential equation of wave motion. Plane progressive waves in fluid media, reflection of waves and phase change, pressure and energy distribution. Principle of superposition of waves, stationary waves, phase and group velocity.	7

Suggested Readings:

PART A

1. Murray Spiegel, Seymour Lipschutz, Dennis Spellman, "Schaum's Outline Series: Vector Analysis", McGraw Hill, 2017, 2e
2. A.W. Joshi, "Matrices and Tensors in Physics", New Age International Private Limited, 1995, 3e

PART B

3. Charles Kittel, Walter D. Knight, Malvin A. Ruderman, Carl A. Helmholz, Burton J. Moyer, "Mechanics (In SI Units): Berkeley Physics Course Vol 1", McGraw Hill, 2017, 2e
4. H. K. Malik and A.K. Singh "Engineering Physics", McGraw Hill Education (India) Private Limited, 2018, 2e.
5. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 1", Pearson Education Limited, 2012
6. Hugh D. Young and Roger A. Freedman, "Sears & Zemansky's University Physics with Modern Physics", Pearson Education Limited, 2017, 14e
7. D.S. Mathur, P.S. Hemne, "Mechanics", S. Chand Publishing, 1981, 3e

Books of local authors:

1. Mathematical Physics, B. D. Gupta, S. Chand Publiction
2. Mathematical Physics, H. D. Das, S. Chand Publiction
3. Mechanics & Wave Motion, Agrawal, Jain & Sharma, Krishna Prakashan, Meerut
4. यान्त्रिकी एवं तरंग गति, अग्रवाल, जैन व शर्मा, कृष्णा प्रकाशन, मेरठ

Suggestive Digital Platforms / Web Links:

8. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
9. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
10. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
11. 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 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

	Online Virtual Lab Experiment List/Link	
	Virtual Labs at Amrita Vishwa Vidyapeetham https://vlab.amrita.edu/?sub=1&brch=74 1. Torque and angular acceleration of a fly wheel 2. Torsional oscillations in different liquids 3. Moment of inertia of flywheel 4. Newton's second law of motion 5. Ballistic pendulum 6. Collision balls 7. Projectile motion 8. Elastic and inelastic collision 9. Spiral Spring Experiment	

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=74
2. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by individual Universities

Suggested Continuous Evaluation Methods:

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

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

- The course can be opted by Botany / Chemistry / Computer Science / Mathematics / Statistics / Zoology
- **PREREQUISITE:** Opted / Passed Semester I, Theory Paper-1 (B010101T)

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: **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

	Bridges - measurement of inductance (Maxwell's, Owen's and Anderson's bridges) and measurement of capacitance (Schering's, Wein's and de Sauty's bridges).	
VI	**Semiconductors & Diodes:** P and N type semiconductors, qualitative idea of Fermi level. Formation of depletion layer in PN junction diode, field & potential at the depletion layer. Qualitative idea of current flow mechanism in forward & reverse biased diode. Diode fabrication. PN junction diode and its characteristics, static and dynamic resistance. Principle, structure, characteristics and applications of Zener, Light Emitting, and Photo diodes. Half and Full wave rectifiers, calculation of ripple factor, rectification efficiency and voltage regulation. Basic idea about filter circuits and voltage regulated power supply.	8
VII	**Transistors:** Bipolar Junction PNP and NPN transistors. Study of CB, CE & CC configurations w.r.t. active, cutoff & saturation regions; characteristics; current, voltage & power gains; transistor currents & relations between them. Idea of base width modulation, base spreading resistance & transition time. DC Load Line analysis and Q-point stabilization. Voltage divider bias circuit for CE amplifier.	8
VIII	**Electronic Instrumentation:** Multimeter: Principles of measurement of dc voltage, dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, electron gun, electrostatic focusing and acceleration (no mathematical treatment). Front panel controls, special features of dual trace CRO, specifications of a CRO and their significance. Applications of CRO to study the waveform and measurement of voltage, current, frequency & phase difference.	7

Suggested Readings:

1. M.W. Zemansky, R. Dittman, "Heat and Thermodynamics", McGraw Hill, 1997, 7e
2. F.W. Sears, G.L. Salinger, "Thermodynamics, Kinetic theory & Statistical thermodynamics", Narosa Publishing House, 1998
3. Enrico Fermi, "Thermodynamics", Dover Publications, 1956
4. S. Garg, R. Bansal, C. Ghosh, "Thermal Physics", McGraw Hill, 2012, 2e
5. Meghnad Saha, B.N. Srivastava, "A Treatise on Heat", Indian Press, 1973, 5e

PART B

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

Books of local authors:

1. Heat and Thermodynamics, Brij Lal Subrahmanyam
2. Refresher Course in Physics, C.L.Arora (for U.P. State Universities), S.Chand Publication
3. Kinetic Theory and Thermodynamics, Agrawal, Jain & Sharma, Krishna Prakashan, Meerut
4. Circuit fundamentals & Basic Electronics, Agrawal, Jain & Sharma, Krishna Prakashan, Meerut
5. अणुगति सिद्धान्त एवं ऊष्मागतिकी, अग्रवाल, जैन व शर्मा, कृष्णा प्रकाशन, मेरठ
6. परिपथ के मूल सिद्धान्त व बेसिक इलेक्ट्रॉनिकी, अग्रवाल, जैन व शर्मा, कृष्णा प्रकाशन, मेरठ

Suggestive Digital Platforms / Web Links:

- MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/

- 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

	C 11. Resonance in series and parallel RCL circuit 12. Characteristics of PN Junction, Zener, Tunnel, Light Emitting and Photo diode 13. Characteristics of a transistor (PNP and NPN) in CE, CB and CC configurations 14. Half wave & full wave rectifiers and Filter circuits 15. Unregulated and Regulated power supply **16.** Various measurements with Cathode Ray Oscilloscope (CRO)	
	Online Virtual Lab Experiment List/Link	
	Thermal Properties of Matter: Virtual Labs at Amrita Vishwa Vidyapeetham https://vlab.amrita.edu/?sub=1&brch=194 1. Heat transfer by radiation 2. Heat transfer by conduction 3. Heat transfer by natural convection 4. The study of phase change 5. Black body radiation: Determination of Stefan's constant 6. Newton's law of cooling 7. Lee's disc apparatus 8. Thermo-couple: Seebeck effects **Semiconductor Devices:** Virtual Labs an initiative of MHRD Govt. of India http://vlabs.iitkgp.ac.in/be/# 9. Familiarisation with resistor 10. Familiarisation with capacitor 11. Familiarisation with inductor 12. Ohm's Law 13. RC Differentiator and integrator 14. VI characteristics of a diode 15. Half & Full wave rectification 16. Capacitative rectification 17. Zener Diode voltage regulator 18. BJT common emitter characteristics 19. BJT common base characteristics 20. Studies on BJT CE amplifier	

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.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
4. A. Sudhakar, S.S. Palli, "Circuits and Networks: Analysis and Synthesis", McGraw Hill, 2015, 5e

Suggestive Digital Platforms / Web Links:

Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=194

Virtual Labs an initiative of MHRD Govt. of India, http://vlabs.iitkgp.ac.in/be/#

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 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:**	

	Electric current & current densities, magnetic force between two current elements. General expression for Magnetic field in terms of volume current density (divergence and curl of Magnetic field), General expression for Magnetic potential in terms of volume current density and Ampere's circuital law (applications included). Study of magnetic dipole (Gilbert & Ampere model). Magnetic fields in matter, magnetization, auxiliary field **H**, magnetic susceptibility and permeability.	8
III	**Time Varying Electromagnetic Fields:** Faraday's laws of electromagnetic induction and Lenz's law. Displacement current, equation of continuity and Maxwell-Ampere's circuital law. Self and mutual induction (applications included). Derivation and physical significance of Maxwell's equations. Theory and working of moving coil ballistic galvanometer (applications included).	7
IV	**Electromagnetic Waves:** Electromagnetic energy density and Poynting vector. Plane electromagnetic waves in linear infinite dielectrics, homogeneous & inhomogeneous plane waves and dispersive & non-dispersive media. Reflection and refraction of homogeneous plane electromagnetic waves, law of reflection, Snell's law, Fresnel's formulae (only for normal incidence & optical frequencies) and Stoke's law.	7
PART B: Physical Optics & Lasers		
V	**Interference:** Conditions for interference and spatial & temporal coherence. Division of Wavefront - Fresnel's Biprism and Lloyd's Mirror. Division of Amplitude - Parallel thin film, wedge shaped film and Newton's Ring experiment. Interferometer - Michelson and Fabry-Perot.	8
VI	**Diffraction:** Distinction between interference and diffraction. Fresnel's and Fraunhofer's class of diffraction. Fresnel's Half Period Zones and Zone plate. Fraunhofer diffraction at a single slit, n slits and Diffracting Grating. Resolving Power of Optical Instruments - Rayleigh's criterion and resolving power of telescope, microscope & grating.	8
VII	**Polarization:** Polarization by dichroic crystals, birefringence, Nicol prism, retardation plates and Babinet's compensator. Analysis of polarized light. Optical Rotation - Fresnel's explanation of optical rotation and Half Shade & Biquartz polarimeters.	7
VIII	**Lasers:** Characteristics and uses of Lasers. Quantitative analysis of Spatial and Temporal coherence. Conditions for Laser action and Einstein's coefficients. Three and four level laser systems (qualitative discussion). Types of lasers and laser.	7

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

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: Perspectives of Modern Physics		
I	**Relativity-Experimental Background:** Structure of space & time in Newtonian mechanics and inertial & non-inertial frames. Galilean transformations. Newtonian relativity. Galilean transformation and Electromagnetism. Attempts to locate the Absolute Frame: Michelson-Morley experiment and significance of the null result. Einstein's postulates of special theory of relativity.	7
II	**Relativity-Relativistic Kinematics:** Structure of space & time in Relativistic mechanics and derivation of Lorentz transformation equations (4-vector formulation included). Consequences of Lorentz Transformation Equations (derivations & examples included): Transformation of Simultaneity (Relativity of simultaneity); Transformation of Length (Length contraction); Transformation of Time (Time dilation); Transformation of Velocity (Relativistic velocity addition); Transformation of Acceleration; Transformation of Mass (Variation of mass with velocity). Relation between Energy & Mass (Einstein's mass & energy relation) and Energy & Momentum.	8
III	**Inadequacies of Classical Mechanics:** Particle Properties of Waves: Spectrum of Black Body radiation, Photoelectric effect, Compton effect and their explanations based on Max Planck's Quantum hypothesis. Wave Properties of Particles: Louis de Broglie's hypothesis of matter waves and their experimental verification by Davisson-Germer's experiment and Thomson's experiment.	8
IV	**Introduction to Quantum Mechanics:** Matter Waves: Mathematical representation, Wavelength, Concept of Wave group, Group (particle) velocity, Phase (wave) velocity and relation between Group & Phase velocities. Wave Function: Functional form, Normalization of wave function, Orthogonal & Orthonormal wave functions and Probabilistic interpretation of wave function based on Born Rule.	7
PART B: Basic Electronics & Introduction to Fiber Optics		
V	**Transistor Biasing:** Faithful amplification & need for biasing. Stability Factors and its calculation for transistor biasing circuits for CE configuration: Fixed Bias (Base Resistor Method), Emitter Bias (Fixed Bias with Emitter Resistor), Collector to Base Bias (Base Bias with Collector Feedback) &, Voltage Divider Bias. Discussion of Emitter-Follower configuration.	7
VI	**Amplifiers:** Classification of amplifiers based on Mode of operation (Class A, B, AB, C & D), Stages (single & multi stage, cascade & cascode connections), Coupling methods (RC, Transformer, Direct & LC couplings), Nature of amplification (Voltage & Power amplification) and Frequency capabilities (AF, IF, RF & VF). Theory & working of RC coupled voltage amplifier (Uses of various resistors & capacitors, and Frequency	7

	response) and Transformer coupled power amplifier (calculation of Power, Effect of temperature, Use of heat sink & Power dissipation). Calculation of Amplifier Efficiency (power efficiency) for Class A Series-Fed, Class A Transformer Coupled, Class B Series-Fed and Class B Transformer Coupled amplifiers.	
VII	**Feedback & Oscillator Circuits:** Feedback Circuits: Effects of positive and negative feedback. Voltage Series, Voltage Shunt, Current Series and Current Shunt feedback connection types and their uses for specific amplifiers. Estimation of Input Impedance, Output Impedance, Gain, Stability, Distortion, Noise and Band Width for Voltage Series negative feedback. Oscillator Circuits: Use of positive feedback for oscillator operation. Barkhausen criterion for self-sustained oscillations. Feedback factor and frequency of oscillation for RC Phase Shift oscillator and Wein Bridge oscillator. Qualitative discussion of Reactive Network feedback oscillators (Tuned oscillator circuits): Hartley & Colpitts oscillators.	8
VIII	**Introduction to Fiber Optics:** Basics of Fiber Optics, step index fiber, graded index fiber, light propagation through an optical fiber, acceptance angle & numerical aperture, qualitative discussion of fiber losses and applications of optical fibers.	8

Suggested Readings:

PART A

1. A. Beiser, Shobhit Mahajan, "Concepts of Modern Physics: Special Indian Edition", McGraw Hill, 2009, 6e
2. H. K. Malik and A.K. Singh "Engineering Physics", McGraw Hill Education (India) Private Limited, 2018, 2e.
3. John R. Taylor, Chris D. Zafiratos, Michael A.Dubson, "Modern Physics for Scientists and Engineers", Prentice-Hall of India Private Limited, 2003, 2e
4. R.A. Serway, C.J. Moses, and C.A. Moyer, "Modern Physics", Cengage Learning India Pvt. Ltd, 2004, 3e
5. R. Resnick, "Introduction to Special Relativity", Wiley India Private Limited, 2007
6. R. Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e

PART B

7. H. K. Malik and A.K. Singh "Engineering Physics", McGraw Hill Education (India) Private Limited, 2018, 2e.
8. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
9. J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
10. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
11. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
12. John M. Senior, "Optical Fiber Communications: Principles and Practice", Pearson Education Limited, 2010, 3e
13. John Wilson, John Hawkes, "Optoelectronics: Principles and Practice", Pearson Education Limited, 2018, 3e
14. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e

Local Author's Books

15. Modern Physics, R. Murugeshan & K. Sivaprasath, S. Chand Publication.
16. Refresher Course in Physics; Vol-II, C.L. Arora, S. Chand Publication.

Suggestive Digital Platforms / Web Links:

17. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
18. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

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/#	

	1. Diode as Clippers 2. Diode as Clampers 3. BJT as switch and Load Lines Virtual Labs an initiative of MHRD Govt. of India http://vlabs.iitkgp.ac.in/be/# 4. RC frequency response Virtual Labs at Amrita Vishwa Vidyapeetham https://vlab.amrita.edu/index.php?sub=1&brch=201 5. Hartley oscillator 6. Colpitt oscillator Virtual Labs at Amrita Vishwa Vidyapeetham http://vlab.amrita.edu/index.php?sub=59&brch=269 7. Fiber Optic Analog and Digital Link 8. Fiber Optic Bi-directional Communication 9. Wavelength Division Multiplexing 10. Measurement of Bending Losses in Optical Fiber 11. Measurement of Numerical Aperture 12. Study of LED and Detector Characteristics	

Suggested Readings:

1. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
2. J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
3. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
4. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
5. John M. Senior, "Optical Fiber Communications: Principles and Practice", Pearson Education Limited, 2010, 3e
6. John Wilson, John Hawkes, "Optoelectronics: Principles and Practice", Pearson Education Limited, 2018, 3e
7. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e

Suggestive Digital Platforms / Web Links:

1. Virtual Labs an initiative of MHRD Govt. of India, http://vlabs.iitkgp.ac.in/psac/#
2. Virtual Labs an initiative of MHRD Govt. of India, http://vlabs.iitkgp.ac.in/be/#
3. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/index.php?sub=1&brch=201
4. Virtual Labs at Amrita Vishwa Vidyapeetham, http://vlab.amrita.edu/index.php?sub=59&brch=269
5. 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 can be opted by Botany / Chemistry / Computer Science / Mathematics / Statistics / Zoology
- **PREREQUISITE:** Opted / Passed Semester IV, Theory Paper-1 (B010401T)

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: **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

	Central Force: Definition and properties of central force. Equation of motion and differential equation of orbit. Bound orbits, stable & non-stable orbits, closed & open orbits. Motion under inverse square law of force and Kepler's laws.	
PART B: Introduction to Statistical Mechanics		
V	**Macrostate & Microstate:** Macrostate, Microstate, Number of accessible microstates and Postulate of equal a priori. Phase space, Phase trajectory, Volume element in phase space, Quantisation of phase space and number of accessible microstates for free particle in 1D, free particle in 3D & harmonic oscillator in 1D.	6
VI	**Concept of Ensemble:** Problem with time average, concept of ensemble, postulate of ensemble average and Liouville's theorem (proof included). Micro Canonical, Canonical & Grand Canonical ensembles. Thermodynamic Probability, Postulate of Equilibrium and Boltzmann Entropy relation.	6
VII	**Distribution Laws:** Statistical Distribution Laws: Expressions for number of accessible microstates, probability & number of particles in i^{th} state at equilibrium for Maxwell-Boltzmann, Bose-Einstein & Fermi-Dirac statistics. Comparison of statistical distribution laws and their physical significance. Canonical Distribution Law: Boltzmann's Canonical Distribution Law, Boltzmann's Partition Function, Proof of Equipartition Theorem (Law of Equipartition of energy) and relation between Partition function and Thermodynamic potentials.	10
VIII	**Applications of Statistical Distribution Laws:** Application of Bose-Einstein Distribution Law: Photons in a black body cavity and derivation of Planck's Distribution Law. Application of Fermi-Dirac Distribution Law: Free electrons in a metal, Definition of Fermi energy, Determination of Fermi energy at absolute zero, Kinetic energy of Fermi gas at absolute zero and concept of Density of States (Density of Orbitals).	8

Suggested Readings:

PART B

1. Herbert Goldstein, Charles P. Poole, John L. Safko, "Classical Mechanics", Pearson Education, India, 2011, 3e
2. N.C. Rana, P.S. Joag, "Classical Mechanics", McGraw Hill, 2017
3. R.G. Takwale, P.S. Puranik, "Introduction to Classical Mechanics", McGraw Hill, 2017

PART B

1. F. Reif, "Statistical Physics (In SI Units): Berkeley Physics Course Vol 5", McGraw Hill, 2017, 1e
2. B.B. Laud, "Fundamentals of Statistical Mechanics", New Age International Private Limited, 2020, 2e
3. B.K. Agarwal, M. Eisner, "Statistical Mechanics", New Age International Private Limited, 2007, 2e

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)

- 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

	Heisenberg uncertainty principle: Commutativity & simultaneity (theorems with proofs). Noncommutativity of operators as the basis for uncertainty principle and derivation of general form of uncertainty principle through Schwarz inequality. Uncertainty principle for various conjugate pairs of physical-dynamical parameters and its applications.	
III	**Quantum Postulates and Schrodinger Equation:** Postulates of quantum mechanics: statements and their physical interpretation. Hamiltonian operator. Schrodinger Equation: formulation (time independent & time dependent forms), Schrodinger equation as an eigen equation, Deviation & interpretation of equation of continuity in Schrodinger representation, and Equation of motion of an operator in Schrodinger representation. Free particle solution of Schrödinger equation.	7
IV	**Applications of Schrodinger Equation:** Application to 1D Problems: Infinite Square well potential (Particle in 1D box), Finite Square well potential, Potential step, Rectangular potential barrier and 1D Harmonic oscillator. Application to 3D Problems: Infinite Square well potential (Particle in a 3D box) and the Hydrogen atom (radial distribution function and radial probability included). (Direct solutions of Hermite, Associated Legendre and Associated Laguerre differential equations to be substituted).	11
PART B: Introduction to Spectroscopy		
V	**Vector Atomic Model:** Inadequacies of Bohr and Bohr-Sommerfeld atomic models w.r.t. spectrum of Hydrogen atom (fine structure of H-alpha line). Modification due to finite mass of nucleus and Deuteron spectrum. Vector atomic model (Stern-Gerlach experiment included) and physical & geometrical interpretations of various quantum numbers for single & many valence electron systems. LS & JJ couplings, spectroscopic notation for energy states, selection rules for transition of electrons and intensity rules for spectral lines. Fine structure of H-alpha line on the basis of vector atomic model.	10
VI	**Spectra of Alkali & Alkaline Elements:** Spectra of alkali elements: Screening constants for s, p, d & f orbitals; sharp, principle, diffuse & fundamental series; doublet structure of spectra and fine structure of Sodium D line. Spectra of alkaline elements: Singlet and triplet structure of spectra.	6
VII	**X-Rays & X-Ray Spectra:** Nature & production, Continuous X-ray spectrum & Duane-Hunt's law, Characteristic X-ray spectrum & Mosley's law, Fine structure of Characteristic X-ray spectrum, and X-ray absorption spectrum.	7
VIII	**Molecular Spectra:** Discrete set of energies of a molecule, electronic, vibrational and rotational energies. Quantisation of vibrational energies, transition rules and pure vibrational spectra. Quantisation of rotational energies, transition rules, pure rotational spectra and determination of inter nuclear distance. Basics of UV Visible & photoluminescence spectroscopy	7

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)

Programme Class: **Degree**	Year: **Third**	Semester: **Fifth**
Subject: **PHYSICS**		
Course Code: **(B010503P)**	Course Title: **Demonstrative Aspects of Optics & Lasers**	
Course Outcomes: Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the optical 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. Fresnel Biprism: Wavelength of sodium light 2. Fresnel Biprism: Thickness of mica sheet) 3. Wavelength of Laser light using diffraction by single slit 4. Study of Spectra of Hydrogen & Deuterium (Rydberg Constant) 5. Laser – Wavelength of Laser light using diffraction by single slit. 6. Study of polarization of light by simple reflection & variation of degree of polarization. 7. Study of Absorption spectrum of Iodine Vapour. 8. Laser beam divergence & spot size. 9. Newton's Rings: Refractive index of liquid 10. Plane Diffraction Grating: Resolving power	60
	Online Virtual Lab Experiment List/Link	
	Virtual Labs at Amrita Vishwa Vidyapeetham https://vlab.amrita.edu/?sub=1&brch=189 1. Michelson's Interferometer 2. Michelson's Interferometer: Wavelength of laser beam 3. Newton's Rings: Wavelength of light 4. Newton's Rings: Refractive index of liquid 5. Brewster's angle determination 6. Laser beam divergence and spot size Virtual Labs at Amrita Vishwa Vidyapeetham https://vlab.amrita.edu/index.php?sub=1&brch=281 7. Spectrometer: Refractive index of the material of a prism 8. Spectrometer: Dispersive power of a prism 9. Spectrometer: Determination of Cauchy's constants 10. Diffraction Grating	

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

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 Solid State Physics		
I	**Crystal Structure:** Lattice, Basis & Crystal structure. Lattice translation vectors, Primitive & non-primitive cells. Symmetry operations, Point group & Space group. 2D & 3D Bravais lattice. Parameters of cubic lattices. Lattice planes and Miller indices. Simple crystal structures - HCP & FCC, Diamond, Cubic Zinc Sulphide, Sodium Chloride, Cesium Chloride and Glasses.	7
II	**Crystal Diffraction:** X-ray diffraction and Bragg's law. Experimental diffraction methods - Laue, Rotating crystal and Powder methods. Derivation of scattered wave amplitude. Reciprocal lattice, Reciprocal lattice vectors and relation between Direct & Reciprocal lattice. Diffraction conditions, Ewald's method and Brillouin zones. Reciprocal lattice to SC, BCC & FCC lattices. Atomic Form factor and Crystal Structure factor.	7
III	**Crystal Bindings:** Classification of Crystals on the Basis of Bonding - Ionic, Covalent, Metallic, van der Waals (Molecular) and Hydrogen bonded. Crystals of inert gases, Attractive interaction (van der Waals-London) & Repulsive interaction, Equilibrium lattice constant, Cohesive energy and Compressibility & Bulk modulus. Ionic crystals, Cohesive energy, Madelung energy and evaluation of Madelung constant.	7
IV	**Lattice Vibrations and Free Electron Theory:** Lattice Vibrations: Lattice vibrations for linear mono & di atomic chains, Dispersion relations and Acoustical & Optical branches (qualitative treatment). Qualitative description of Phonons in solids. Lattice heat capacity, Free Electron Theory: Fermi energy, Density of states, Heat capacity of conduction electrons, Paramagnetic susceptibility of conduction electrons and Hall effect in metals. Band Theory: Origin of band theory, Qualitative idea of Bloch theorem, Kronig-Penney model, Effective mass of an electron & Concept of Holes & Classification of solids on the basis of band theory.	9
PART B: Introduction to Nuclear Physics		
V	**Nuclear Forces & Radioactive Decays:** General Properties of Nucleus: Mass, binding energy, radii, density, angular momentum, magnetic dipole moment vector and basic idea of electric quadrupole moment tensor. Nuclear Forces: General characteristic of nuclear force and Deuteron ground state properties. Radioactive Decays: Nuclear stability, basic ideas about beta minus decay, beta plus decay, alpha decay, gamma decay & electron capture, fundamental laws of radioactive disintegration and radioactive series.	9
VI	**Nuclear Models & Nuclear Reactions:** Nuclear Models: Liquid drop model and Bethe-Weizsacker mass formula. Introduction of Single particle shell model and magic numbers.	9

	Nuclear Reactions: Bethe's notation, types of nuclear reaction, Conservation laws, Cross-section of nuclear reaction, Theory of nuclear fission (qualitative), Nuclear reactor and nuclear fusion.	
VII	**Accelerators & Detectors:** Accelerators: Theory, working and applications of Van de Graaff accelerator, Cyclotron and Synchrotron. Detectors: Theory, working and applications of GM counter, Semiconductor detector, Scintillation counter and Wilson cloud chamber.	6
VIII	**Elementary Particles:** Fundamental interactions & their mediating quanta. Concept of antiparticles. Classification of elementary particles based on intrinsic-spin, mass, interaction & lifetime. Families of Leptons, Mesons, Baryons & Baryon Resonances. Conservation laws for mass-energy, linear momentum, angular momentum, electric charge, baryonic charge, leptonic charge, isospin & strangeness. Concept of Quark model.	6

Suggested Readings:

PART A

1. Charles Kittel, "Introduction to Solid State Physics", Wiley India Private Limited, 2012, 8e
2. H. K. Malik and A.K. Singh "Engineering Physics", McGraw Hill Education (India) Private Limited, 2018, 2e.
3. A.J. Dekker, "Solid State Physics", Macmillan India Limited, 1993
4. R.K. Puri, V.K. Babbar, "Solid State Physics", S. Chand Publishing, 2015

PART B

5. H. K. Malik and A.K. Singh "Engineering Physics", McGraw Hill Education (India) Private Limited, 2018, 2e.
6. Kenneth S. Krane, "Introductory Nuclear Physics", Wiley India Private Limited, 2008
7. Bernard L. Cohen, "Concepts of Nuclear Physics", McGraw Hill, 2017
8. S.N. Ghoshal, "Nuclear Physics", S. Chand Publishing, 2019

Local Author's Books

9. Atomic and Nuclear Physics, Brij Lal, S. Chand Publication.
10. Nuclear Physics, S.N. Ghoshal, S. Chand Publication.
11. Atomic and Molecular Physics, Agarwal, Jain & Sharma, Krishna Prakashan.

Suggestive Digital Platforms / Web Links:

12. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
13. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
14. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
15. 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 V, Theory Paper-2 (B010502T)

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

	configuration (Self Bias & Voltage Divider Bias); Amplifiers (CS & CD or Source Follower); Comparison (N & P channels and BJTs & JFETs). MOSFET: Construction and Working of D-MOSFET (N channel & P channel) and E-MOSFET (N channel & P channel); Characteristics (Drain & Transfer) of D-MOSFET and E-MOSFET; Comparison of JFET and MOSFET.	
IV	**Other Devices:** SCR: Construction; Equivalent Circuits (Two Diodes, Two Transistors & One Diode-One Transistor); Working (Off state & On state); Characteristics; Applications (Static switch, Phase control system & Battery charger). UJT: Construction; Equivalent Circuit; Working (Cutoff, Negative Resistance & Saturation regions); Characteristics (Peak & Valley points); Applications (Trigger circuits, Relaxation oscillators & Sawtooth generators).	5
PART B: Digital Electronics		
V	**Number System:** Number Systems: Binary, Octal, Decimal & Hexadecimal number systems and their inter conversion. Binary Codes: BCD, Excess-3 (XS3), Parity, Gray, ASCII & EBCDIC Codes and their advantages & disadvantages. Data representation.	6
VI	**Binary Arithmetic:** Binary Addition, Decimal Subtraction using 9's & 10's complement, Binary Subtraction using 1's & 2's compliment, Multiplication and Division.	5
VII	**Logic Gates:** Truth Table, Symbolic Representation and Properties of OR, AND, NOT, NOR, NAND, EX-OR & EX-NOR Gates. Implementation of OR, AND & NOT gates (realization using diodes & transistor). De Morgan's theorems. NOR & NAND gates as Universal Gates. Application of EX-OR & EX-NOR gates as pairty checker. Boolean Algebra. Karnaugh Map.	9
VIII	**Combinational & Sequential Circuits:** Combinational Circuits: Half Adder, Full Adder, Parallel Adder, Half Substractor, Full Substractor. Data Processing Circuits: Multiplexer, Demultiplexer, Decoders & Encoders. Sequential Circuits: SR, JK & D Flip-Flops, Shift Register (transfer operation of Flip-Flops), and Asynchronous & Synchronous counters.	10

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**	

Unit	Topics	No. of Lectures
	Lab Experiment List	
	1. Energy band gap of semiconductor by reverse saturation current method 2. Energy band gap of semiconductor by four probe method 3. Hybrid parameters of transistor 4. Characteristics of FET, MOSFET, SCR, UJT 5. FET Conventional Amplifier 6. FET as VVR and VCA 7. Study and Verification of AND gate using TTL IC 7408 8. Study and Verification of OR gate using TTL IC 7432 9. Study and Verification of NAND gate and use as Universal gate using TTL IC 7400 10. Study and Verification of NOR gate and use as Universal gate using TTL IC 7402 11. Study and Verification of NOT gate using TTL IC 7404 12. Study and Verification of Ex-OR gate using TTL IC 7486	60
	Online Virtual Lab Experiment List/Link	
	Virtual Labs an initiative of MHRD Govt. of India http://vlabs.iitkgp.ac.in/ssd/# 1. ID-VD characteristics of Junction Field Effect Transistor (JFET) 2. Silicon Controlled Rectifier (SCR) characteristics 3. Unijunction Transistor (UJT) and relaxation oscillator Virtual Labs an initiative of MHRD Govt. of India https://de-iitr.vlabs.ac.in/List%20of%20experiments.html 4. Verification and interpretation of truth table for AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates 5. Construction of half and full adder using XOR and NAND gates and verification of its operation 6. To study and verify half and full subtractor 7. Realization of logic functions with the help of Universal Gates (NAND, NOR) 8. Construction of a NOR gate latch and verification of its operation 9. Verify the truth table of RS, JK, T and D Flip Flops using NAND and NOR gates 10. Design and Verify the 4-Bit Serial In - Parallel Out Shift Registers 11. Implementation and verification of decoder or demultiplexer and encoder using logic gates 12. Implementation of 4x1 multiplexer and 1x4 demultiplexer using logic gates 13. Design and verify the 4-Bit Synchronous or Asynchronous Counter using JK Flip Flop 14. Verify Binary to Gray and Gray to Binary conversion using NAND gates only	

	15. Verify the truth table of 1-Bit and 2-Bit comparator using logic gates	

Suggested Readings:

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

Suggestive Digital Platforms / Web Links:

1. Virtual Labs an initiative of MHRD Govt. of India, http://vlabs.iitkgp.ac.in/ssd/#
2. Virtual Labs an initiative of MHRD Govt. of India, https://de-iitr.vlabs.ac.in/List%20of%20experiments.html
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)**

- The course can be opted by Botany / Chemistry / Computer Science / Mathematics / Statistics
- **PREREQUISITE:** Opted / Passed Semester VI, Theory Paper-2 (B010602T)

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.

Important Note: The members of the Board of Studies suggested that there should be some more additional core elective courses/papers in fifth and sixth semesters, whose detailed syllabi may be developed before the start of third year of B.Sc. (Physics).

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

II	**The Sun and our Solar System:** The internal structure of the sun, Characteristics of the sun, different layers of the sun; the core, the radiative zone, the convection zone, Solar atmosphere, the photosphere, the chromosphere, the corona, Differential rotation of the sun, Formation of sunspots, solar cycle or sunspot cycle, Magnetic fields on the sun, Energetic events on the sun; solar flares, coronal mass ejections, Formation of the solar system, Inner solar system; Mercury, Venus, Earth, Mars, asteroids, Outer solar system; Jupiter, Saturn, Uranus, neptune, comets, Kuiper belts, Dwarf planets.	17
PART B: Climate Change and Environment Policies		
III	**Global warming and climate change:** Natural greenhouse effect, Greenhouse effect due to anthropogenic sources, Concentration of various greenhouse gases in earth's environment; concentration of carbon-dioxide, concentration of methane, concentration of nitrous oxide, concentration of fluorocarbons, Climate forcing, Trends of global warming and climate change; change in rain patterns, melting of glaciers and rising sea levels, damage to coral reefs, stronger storms, shifting of wild life species, change in plant's life cycle, droughts, Impact on economy and spread of acute human disease.	18
IV	**Ozone layer depletion, environmental policy & agreements**: Ozone layer or ozone shield; importance of ozone layer; ozone layer depletion and causes; Chapman cycle; process of spring time ozone depletion over Antarctica; ozone depleting substances (ODS); effects of ozone depletion; mitigation measures and international protocols. Environmental policy debate; International agreements; Montreal protocol 1987; Kyoto protocol 1997; Convention on Climate Change; carbon credit and carbon trading; clean development mechanism.	12

Suggestive readings:

1. A Chandrasekar, 2010, Basics of Atmospheric Science, PHI Publication.
2. National Research Council, 2014, Solar and Space Physics: A science for a technological society: An overview, Washington DC: The National Academics Press. https://doi.org/10.17226/18974.
3. Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.
4. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.
5. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
6. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
7. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.

Online Resources:

1. *IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II & III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Chan* https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf
2. Gautam Yogendra K., Sharma Kavita, Tyagi Shrestha, Ambedkar Anit K., Chaudhary Manika and Beer Pal Singh, Nanostructured metal oxide semiconductor-based sensors for greenhouse gas detection: progress and challenges, Royal Society open science, 201324201324, http://doi.org/10.1098/rsos.201324.
3. https://www.epa.gov/ghgemissions/overview-greenhouse-gases.
4. Introduction to atmospheric science, https://nptel.ac.in/courses/119/106/119106008/

Suggestive continuous internal evaluation Method:

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)**

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 Second	Semester Third
Subject: **PHYSICS**		
Course Code: **(B010303T)**	Course Title: **Renewable Energy Sources**	
Course Outcomes: After completing this course, a student will have:		
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: Fossil Fuel and Solar Energy		
I	**FOSSIL FUELS AND ALTERNATE SOURCES OF ENERGY:** **Energy (Definition),** Sun as the source of energy (fission reactions), **Classification of energy Sources:** Primary energy, commercial (sources that are found in market for a definite price) and noncommercial (not available in market for any price) energy,	15

	renewable and nonrenewable energy, conventional and non-conventional energy. **Fossil fuels and nuclear energy**: (Introduction and usage, their advantages and limitations), requirement of alternate sources of energy, **Basic understanding of Alternate sources of energy**: (Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion (OTEC), solar energy, biomass, biochemical conversion, biogas energy, geothermal energy Hydroelectricity).	
II	**SOLAR ENERGY** Introduction (solar energy is one of the most resourceful sources of energy), units of solar energy and solar power, Essentials of solar energy plant solar collector, Energy transport system like water or steam, electrical system, Energy storage (thermal energy storage and battery storage), Energy conversion plant (thermal energy collected by solar collectors), Power conditioning, control and protection system. Principle of photovoltaic conversion of solar energy. **Applications of solar system**: Battery storage & solar water pumping,	15
PART B: Wind and Bioenergy		
III	**WIND ENERGY** Introduction, Wind Resources (windmill, its working and conversion system), Meteorology of wind (wind speed predictions, schematic diagram of wind power system), India's wind energy potential and challenges **(**benefits of desert lands and sea area), distribution across the world, Eolian features (definition only), Factors affecting wind energy.	15
IV	**BIOENERGY** **Bioenergy** (energy produced by biofuels): bioenergy and sustainability, Energy density (definition only), **Biomass as resources:** Classification and estimation of biomass (sugarcane agro industry, advantages and dangers of energy farming), Source and characteristics of biofuels (production and uses), Biodiesel & Bioethanol (production from ethanol), Biogas, conversion of waste produce into energy.	15

Suggestive readings:

1. Kothari P, Singal K C and Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", PHI Pvt. Ltd., New Delhi,2008.
2. Sukhatme S P and Nayak J K, "Solar Energy – Principles of Thermal Collection and Storage", Tata McGraw Hill, 2008.
3. Rai G D, "Non-Conventional Sources of Energy", Khanna Publishers, 2006.
4. Abbasi SA A and Naseema Abbasi, "Renewable Energy Sources and their Environmental Impact", PHI Pvt. Ltd., 2001.
5. Frank Kreith and Yogi Goswami D, "Handbook of Energy Efficiency and Renewable Energy", CRC Press, 2007
6. Bent Sorensen, "Renewable Energy", Academic Press, 2004
8. Boyle G, "Renewable energy: Power for a sustainable future", Oxford University Press, 2004.
7. www.fao.org>docs>fileadmin.

8. Webstor.srmist.edu.in
9. Alternate_energy_ebook.pdf
10. www.vssut.ac.in>lecture>pdf

Suggestive continuous internal evaluation Method:

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)**

Chaudhary Charan Singh University, Meerut

Syllabus of the Subject

Mathematics

For First Three Years of Under-Graduate (UG) Programme

As per guidelines of Common Minimum Syllabus by U.P. Government according to National Education Policy-2020

w.e.f. the session 2021-2022

(For both University Campus and Colleges)

Members of the Board of Studies

S. No.	Name	Signature
1	Prof. M.K. Gupta- (Dean) Science Faculty	
2	Prof. Shiv Raj Singh, Convener-I	
3	Dr (Smt.) Shashi Sharma, Convener-II	
4	Dr Kunwar Pal Singh, Internal Subject Expert	
5	Dr Rishi Kumar Agarwal, Internal Subject Expert	
6	Prof. Anil Vashistha, External Subject Expert	
7	Prof. C.K. Goel, External Subject Expert	
8	Prof. R.C. Mittal, External Subject Expert	
9	Prof. G.C. Sharma, (Retd.) Principal	
10	Dr Pramod Kumar Sahoo, Scientist	

SEMESTER WISE TITLES OF THE PAPER IN UG MATHEMATICS COURSE					
YEAR	**SEMESTER**	**COURSE CODE**	**PAPER TITLE**	**THEORY/PRACTICAL**	**CREDIT**
CERTIFICATE COURSE IN APPLIED MATHEMATICS					
FIRST YEAR	**I**	B030101T	Differential Calculus & Integral Calculus	THEORY	**4**
		B030102P	PRACTICAL	PRACTICAL	**2**
	II	B030201T	Matrices and Differential Equations & Geometry	THEORY	**6**
DIPLOMA IN MATHEMATICS					
SECOND YEAR	**III**	B030301T	Algebra & Mathematical Methods	THEORY	**6**
	IV	B030401T	Differential Equation & Mechanic	THEORY	**6**
DEGREE IN MATHEMATICS					
THIRD YEAR	**V**	B030501T	Group and Ring Theory & Linear Algebra	THEORY	**5**
		B030502T	Any One of the following (i) Number Theory & Game Theory (ii) Graph Theory & Discrete Mathematics (iii) Differential Geometry & Tensor Analysis	THEORY	**5**
	VI	B030601T	Metric Space & Complex Analysis	THEORY	**4**
		B030602T	Numerical Analysis & Operations Research	THEORY	**4**
		B030603P	PRACTICAL	PRACTICAL	**2**

PROPOSED STRUCTURE OF UG MATHEMATICS SYLLABUS AS PER NEP 2020 GUIDELINES

GENERAL OVERVIEW

B.A./B.Sc. I										
PROGRAMME	**YEAR**	**SEMESTER (15 Weeks)**	**PAPER**	**CREDIT**	**PERIODS Per Week**	**PERIODS (HOURS) Per Semester**	**PAPER TITLE**	**UNIT (Periods Per Semester)**	**PREREQUISITE**	**ELECTIVE (For Other Faculty)**
CERTIFICATE COURSE IN APPLIED MATHEMATICS	**FIRST YEAR**	**SEMESTER – I**	**Paper-1**	**4**	**4**	4x 15= 60	**Differential Calculus & Integral Calculus** **Part A: Differential Calculus** **Part B: Integral Calculus**	**Part A** Unit I (9) Unit II (7) Unit III (7) Unit IV (7) **Part B** Unit V (9) Unit VI (7) Unit VII (7) Unit VIII (7)	Mathematics in 12th	Engg. and Tech. (UG), Chemistry/Biochemistry/ Life Sciences (UG), Economics (UG/PG), Commerce (UG), BBA/BCA, B.Sc. (C.S.)
			Paper-II Practical	**2**	**2 Lab Periods (2Hours Each)**	2x2x 15= 60	**Practical** (Practicals to be done using Mathematica /MATLAB /Maple /Scilab/Maxima etc.)		Mathematics in 12th	Engg. and Tech. (UG), B.Sc.(C.S.)
		SEMESTER – II	**Paper-1**	**6**	**6**	6 x 15= 90	**Matrices and Differential Equations & Geometry** **Part A: Matrices and Differential Equations** **Part B: Geometry**	**Part A** Unit I (12) Unit II (11) Unit III (11) Unit IV (11) **Part B** Unit V (12) Unit VI (11) Unit VII (11) Unit VIII (11)	Mathematics in 12th	Engg. and Tech. (UG), B.Sc.(C.S.)

B.A./B.Sc. II

PROGRAMME	YEAR	SEMESTER (15 Weeks)	PAPER	CREDIT	PERIODS Per Week	PERIODS (HOURS) Per Semester	PAPER TITLE	UNIT (Periods Per Semester)	PREREQUISITE	ELECTIVE (For Other Faculty)
DIPLOMA IN MATHEMATICS	SECOND YEAR	SEMESTER –III	Paper-1	6	6	6 x 15= 90	**Algebra & Mathematical Methods** **Part A: Algebra** **Part B: Mathematical Methods**	**Part A** Unit I (12) Unit II (11) Unit III (11) Unit IV (11) **Part B** Unit V (12) Unit VI (11) Unit VII (11) Unit VIII (11)	Certificate Course in Applied Mathematics	Engg. and Tech. (UG), B.Sc. (C.S.)
		SEMESTER – IV	Paper-1	6	6	6 x 15= 90	**Differential Equation & Mechanics** **Part A: Differential Equation** **Part B: Mechanics**	**Part A** Unit I (12) Unit II (11) Unit III (11) Unit IV (11) **Part B** Unit V (12) Unit VI (11) Unit VII (11) Unit VIII (11)	Certificate Course in Applied Mathematics	Engg. and Tech. (UG), Economics (UG/PG), B.Sc. (C.S.) Engineering and Technology (UG), Science (Physics-UG)

B.A./B.Sc. III

PROGRAMME	YEAR	SEMESTER (15 Weeks)	PAPER	CREDIT	PERIODS Per Week	PERIODS (HOURS) Per Semester	PAPER TITLE	UNIT (Periods Per Semester)	PREREQUISITE	ELECTIVE (For Other Faculty)
DEGREE IN MATHEMATICS	THIRD YERAR	SEMESTER – V	Paper-1	5	5	5x 15= 75	**Group and Ring Theory & Linear Algebra** **Part A: Group and Ring Theory** **Part B: Linear Algebra**	**Part A** Unit I (10) Unit II (10) Unit III (9) Unit IV (9) **Part B** Unit V (10) Unit VI (9) Unit VII (9) Unit VIII (9)	Certificate Course in Applied Mathematics	Engg. and Tech. (UG), Economics (UG/PG), B.Sc. (C.S.)
			Paper-2	5	5	5x 15= 75	**(i) Number Theory & Game Theory** **Part A: Number Theory** **Part B: Game Theory**	**Part A** Unit I (10) Unit II (9) Unit III (9) Unit IV (9) **Part B** Unit V (10) Unit VI (10) Unit VII (9) Unit VIII (9)	Diploma in Mathematics	Engg. and Tech. (UG), BCA, B.Sc. (C.S.)
							(ii) Graph Theory & Discrete Mathematics **Part A: Graph Theory** **Part B: Discrete Mathematics**	**Part A** Unit I (10) Unit II (9) Unit III (9) Unit IV (9) **Part B** Unit V (10) Unit VI (10) Unit VII (9) Unit VIII (9)	Diploma in Mathematics	Engg. and Tech. (UG), B.Sc. (C.S.)
							(iii) Differential Geometry & Tensor Analysis **Part A: Differential Geometry** **Part B: Tensor Analysis**	**Part A** Unit I (10) Unit II (9) Unit III (9) Unit IV (9) **Part B** Unit V (10) Unit VI (10) Unit VII (9) Unit VIII (9)	Diploma in Mathematics	Engg. and Tech. (UG), B.Sc. (C.S.)

		SEMESTER – VI	Paper-1	**4**	**4**	4 x 15= 60	**Metric Space & Complex Analysis** **Part A: Metric Space** **Part B: Complex Analysis**	**Part A** Unit I (8) Unit II (8) Unit III (7) Unit IV (7) **Part B** Unit V (8) Unit VI (8) Unit VII (7) Unit VIII (7)	Diploma in Mathematics	Engg. and Tech. (UG), B.Sc. (C.S.)
			Paper-2	**4**	**4**	4x 15= 60	**Numerical Analysis & Operations Research** **Part A: Numerical Analysis** **Part B: Operations Research**	**Part A** Unit I (8) Unit II (8) Unit III (7) Unit IV (7) **Part B** Unit V (8) Unit VI (8) Unit VII (7) Unit VIII (7)	Diploma in Mathematics	Engg. and Tech. (UG), Economics (UG/PG),BBA/BCA, B.Sc. (C.S.)
			Paper-III Practical	**2**	**2 Lab Periods (2Hours Each)**	2x2x 15= 60	**Practical** (Practicals to be done using Mathematica /MATLAB /Maple /Scilab/Maxima etc.)		Diploma in Mathematics	Engg. and Tech. (UG), B.Sc. (C.S.)

Programme Outcome/ Programme Specific Outcome

Programme Outcome:

PO1: It is to give foundation knowledge for the students to understand basics of mathematics including applied aspect for the same.
PO2: It is to develop enhanced quantitative skills and pursuing higher mathematics and research as well.
PO3: Students will be able to develop solution-oriented approach towards various issues related to their environment.
PO4: Students will become employable in various govt. and private sectors
PO5: Scientific temper in general and mathematical temper in particular will be developed in students.

Programme Specific Outcome:

PSO1: Student should be able to possess recall basic idea about mathematics which can be displayed by them.
PSO2: Student should have adequate exposure to many aspects of mathematical sciences.
PSO3: Student is equipped with mathematical modeling ability, critical mathematical thinking, and problem-solving skills etc.
PSO4: Student should be able to apply their skills and knowledge in various fields of studies including, science, engineering, commerce and management etc.

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

Detailed Syllabus For

CERTIFICATE COURSE

IN

APPLIED MATHEMATICS

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

Part-B
Integral Calculus

Unit	Topics	No. of Lectures
V	Concept of partition of interval, Properties of Partitions, Riemann integral, Criterion of Riemann Integrability of a function, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus. Differentiation under the sign of Integration.	9
VI	Improper integrals, their classification and convergence, Comparison test, μ-test, Abel's test, Dirichlet's test, quotient test, Beta and Gamma functions.	7
VII	Rectification, Volumes and Surfaces of Solid of revolution, Pappus theorem, Multiple integrals, change of order of double integration, Dirichlet's theorem, Liouville's theorem for multiple integrals.	7
VIII	Vector Differentiation, Gradient, Divergence and Curl, Normal on a surface, Directional Derivative, Vector Integration., Statements of Theorems, of Gauss, Green & Stokes, only without proof, Applications of these theorems for evaluation of double and triple integrals.	7

Suggested Readings (Part- A Differential Calculus):

1. R.G. Bartle & D.R. Sherbert, **Introduction to Real Analysis**, John Wiley & Sons, 1999
2. T.M. Apostal, **Calculus Vol. I**, John Wiley & Sons Inc., 1974
3. Ajit Kumar and S. Kumaresan, **A Basic Course in Real Analysis**, CRC Press, 2019
4. S. Balachandra Rao & C. K. Shantha, **Differential Calculus**, New Age Publication. 1992
5. H. Anton, I. Birens and S. Davis, **Calculus**, John Wiley and Sons, Inc. 2007
6. G.B. Thomas and R.L. Finney, **Calculus**, Pearson Education, 2010
7. Wilson A Sutherland, **Introduction to Metric and Topological Spaces**, Oxford University Press, 2009
8. Suggestive digital platforms web links: NPTEL/SWAYAM/MOOCS

Suggested Readings (Part-B Integral Calculus):

1. T.M. Apostol, **Calculus Vol. II**, John Wiley Publication, 1974
2. Withold A.J. Kosmala, **A Friendly Introduction to Analysis, Single and Multivariable**, Pearson/Prentice Hall, 2003
3. Shanti Narayan & P.K. Mittal, **Integral Calculus**, S Chand, 2005
4. Erwin Kreyszig, **Advanced Engineering Mathematics**, John Wiley & Sons. 2011
5. Suggestive digital platforms web links: NPTEL/SWAYAM/MOOCS

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

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment (Introduction to Indian ancient Mathematics and Mathematicians).**	**5**

Course prerequisites: To study this course, a student must have subject Mathematics in class 12th

Suggested equivalent online courses:

Further Suggestions:

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.

	iv. Graph of circular and hyperbolic functions. **v.** Obtaining surface of revolution of curves. **vi.** Complex numbers and their representations, Operations like addition, Multiplication, Division, Modulus. Graphical representationof polar form. **vii.** Find numbers between two real numbers and plotting of finite and infinite subset of R. **viii.** Matrix Operations: Addition, Multiplication, Inverse, Transpose, Determinant, **ix.** Study the convergence of sequences through plotting. **x.** Verify Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent subsequences from the plot. **xi.** Study the convergence/divergence of infinite series by plotting their sequences of partial sum. **xii.** Cauchy's root test by plotting n^{th} roots. **xiii.** Ratio test by plotting the ratio of n^{th} and $(n+1)^{th}$ term.	

Suggested Readings

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

Suggested Continuous Evaluation Methods: Max. Marks: 25

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

Course prerequisites: To study this course, a student must have subject Mathematics in class 12^{th}

Suggested equivalent online courses:

Further Suggestions:

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**

PART-B

Geometry

Unit	Topics	No. of Lectures
V	General equation of second degree, System of conics, Tracing of conics, Confocal conics, Polar equation of conics and its properties.	12
VI	Three-Dimensional Coordinates, Projection and Direction Cosine, Plane (Cartesian and vector form), Straight line in three dimensions.	11
VII	Sphere, Cone and Cylinder.	11
VIII	Central conicoid, Paraboloids, Plane section of conicoid, Generating lines, Confocal conicoid, Reduction of second degree equations.	11

Suggested Readings (PART-A Matrices and Differential Equations):

1. Shanti Narayan, **A Textbook of Matrices**, S. Chand, 2010
2. Fuzhen Zhang, **Matrix Theory- Basic Results and Techniques**, Springer,1999
3. B. Rai, D.P. Choudhary & H. J. Freedman, **A Course in Differential Equations**, Narosa, 2002
4. William E Boyce and Richard C Di Prima, **Elementary Differential Equations and Boundary Value Problems**, John Wiley and Sons, 2009
5. D.A. Murray, **Introductory Course in Differential Equations**, Orient Longman, 1967
6. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Suggested Readings (Part-B Geometry):

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

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

Suggested Continuous Evaluation Methods: Max. Marks: 25

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

Course prerequisites: To study this course, a student must have subject Mathematics in class 12^{th}

Suggested equivalent online courses:

Further Suggestions:

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

Detailed Syllabus For

DIPLOMA IN MATHEMATICS

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**

Part- B
Mathematical Methods

Unit	Topics	No. of Lectures
V	Limit and Continuity of functions of two variables, Differentiation of function of two variables, Necessary and sufficient condition for differentiability of functions two variables, Schwarz's and Young theorem (Statement Only), Taylor's theorem for functions of two variables with examples, Maxima and minima for functions of two variables, Lagrange multiplier method, Jacobians.	12
VI	Existence theorems for Laplace transforms, Linearity of Laplace transform and their properties, Laplace transform of the derivatives, Initial and final value theorems and Evaluation of Integrals of a function	11
VII	Inverse Laplace transforms, Linearity of Inverse Laplace transform, Shifting theorems (first and second), Convolution theorem. Solution of the differential equations using Laplace transforms.	11
VIII	Fourier series, Fourier expansion of piecewise monotonic functions, Half and full range expansions, Fourier transforms (finite and infinite), Application of Fourier Transform in initial and boundary value problem. Fourier integral. **The topic "Indian Ancient Mathematics and Mathematicians should be covered under Continuous Internal Evaluation (CIE). (Appendix)**	11

Suggested Readings (Part-A Algebra):

1. J.B. Fraleigh, **A first course in Abstract Algebra**, Addison-wiley, 2003
2. I. N. Herstein, **Topics in Algebra**, John Wiley & Sons, 2006
3. Thomas W Hungerford, **Abstract Algebra – An Introduction**, Sauders College Publishing 1990
4. Joseph A Gallian, **Contemporary Abstract Algebra**, Brooks/Cole Cengage Learning, 2016
5. Suggested digital platform: NPTEL/SWAYAM/MOOCS

Suggested Readings (Part- B Mathematical Methods):

1. T.M. Apostol, **Mathematical Analysis**, Person, 1974
2. G.F. Simmons, **Differential Equations with Applications and Historical Notes**, Tata -Mc Graw Hill 2002
3. Erwin Kreyszig, **Advanced Engineering Mathematics**, John Wiley & Sons. 2011
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs

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

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment (Introduction to Indian ancient Mathematics and Mathematicians)**	**5**

Course prerequisites: To study this course, a student must have subject Mathematics in class 12^{th}

Suggested equivalent online courses:

Further Suggestions:

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**

Part- B

Mechanics

Unit	Topics	No. of Lectures
V	Frame of reference, work energy principle, Forces in three dimensions, Poinsot's central axis, Wrenches, Null lines and planes.	10
VI	Virtual work, Stable and Unstable equilibrium, Potential energy test, Z-test, stability of a body resting on a fixed rough surface.	9
VII	Velocities and accelerations along radial and transverse directions, and along tangential and normal directions, Simple Harmonic motion, Motion under other law of forces.	9
VIII	Elastic strings, Motion in resisting medium, Constrained motion, Motion on smooth and rough plane curves. Central orbit. Kepler's laws of motion,	9

Suggested Readings (Part-A Differential Equations):

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

Suggested Readings (Part-B Mechanics):

1. R.C. Hibbeler, **Engineering Mechanics-Statics**, Prentice Hall Publishers 2010
2. R.C. Hibbeler, **Engineering Mechanics-Dynamics**, Prentice Hall Publishers 2012
3. A. Nelson, **Engineering Mechanics Statics and Dynamics**, Tata McGraw Hill 2009
4. J.L. Synge & B.A. Griffith, **Principles of Mechanics**, Tata McGraw Hill 2018
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs

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

Suggested Continuous Evaluation Methods: Max. Marks: 25

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

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

Suggested equivalent online courses:

Further Suggestions:

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

Detailed Syllabus For

DEGREE IN MATHEMATICS

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**

PART-B

Linear Algebra

Unit	Topics	No. of Lectures
V	Vector spaces and their elementary properties Subspaces, Linear independence and dependence of vectors, Basis and Dimension, Direct sum, Quotient space.	10
VI	Linear transformations, The Algebra of linear transformations, Range and Null space of a linear Transformation	10
VII	Rank and nullity theorem, their representation as Linear Transformations and matrices, Change of Basis.	9
VIII	Inner product spaces and norms, Cauchy-Schwarz inequality, Orthogonal vectors, Orthonormal sets and bases, Bessel's inequality for finite dimensional spaces, Gram-Schmidt orthogonalization process. **The topic "Indian Ancient Mathematics and Mathematicians" should be covered under Continuous Internal Evaluation (CIE). (Appendix)**	9

Suggested Readings:

1. I. N. Herstein, **Topics in Algebra**. 2006
2. B. Dubey, **Introductory Linear Algebra**, Asian Books Pvt Ltd, 2007
3. K. Hoffman and R. Kunze**, Linear Algebra**. 2015
4. David C Lay**, Linear Algebra**, Pearson 2016
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs

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

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	10
2	**Online Quizzes/ Objective Tests**	5
3	**Presentation**	5
4	**Assignment (Introduction to Indian ancient Mathematics and Mathematicians)**	5

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

Suggested equivalent online courses:

Further Suggestions:

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**

Part- B
Game Theory

Unit	Topics	No. of Lectures
V	Introduction, overview, uses of game theory, some applications and examples, and formal definitions of: the normal form, payoffs, strategies, pure strategy Nash equilibrium.	10
VI	Introduction, characteristic of game theory, Two- person zero-sum game, Pure and Mixed strategies, Saddle point and its existence.	10
VII	Fundamental Theorem of Rectangular games, Concept of Dominance, Dominance and Graphical method of solving rectangular games.	9
VIII	Relationship between rectangular game and Linear Programming Problem, reduction of m x n game and solution of 2x2, 2 x s, and r x 2 cases by graphical method. algebraic and linear programming solution of m x n games.	9

Suggested Readings (Part-A Number Theory):

1. Niven, I., Zuckerman, H. S. and Montegomery, H. L. **An Int. to the Theory of Numbers** John Wiley and sons, 2003
2. Burton, D. M., **Elementary Number Theory** (4th edition) Universal Book Stall, 2002
3. Balakrishnan, V. K., **Schaum's Outline of Theory and Problems of Combinatorics Including Concepts of Graph Theory**, Mc Graw Hill, 1995
4. Balakrishnan, V. K., **Introductory Discrete Mathematics**, Dover Publications, 1996
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Suggested Readings (Part-B Game Theory):

1. Martin Osborne, **An Introduction to Game Theory**, Oxford University Press, 2003
2. Vijay Krishna, **Game Theory**, Academic Press.
3. Prajit Dutta, **Strategies and Games**, MIT Press, 1999 (Website 1) http://www.ece.stevens-tech.edu/~ccomanic/ee800c.html
4. Allan Mac Kenzie, **Game Theory for Wireless Engineers**, Synthesis lectures on Communications, 2006
5. Suggested digital platform: NPTEL/SWAYAM/MOOCS

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

Suggested Continuous Evaluation Methods: Max. Marks: 25

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

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

Suggested equivalent online courses:

Further Suggestions:

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**

Part- B
Discrete Mathematics

Unit	Topics	No. of Lectures
V	**Propositional Logic-** Proposition logic, basic logic, logical connectives, truth tables, tautologies, contradiction, normal forms (conjunctive and disjunctive), modus ponens and modus tollens, validity, predicate logic, universal and existential quantification, proof by implication, converse, inverse contrapositive, contradiction, direct proof by using truth table.	**10**
VI	**Relation-** Definition, types of relation, domain and range of a relation, pictorial representation of relation, properties of relation, partial ordering relation. Representation of POSETS using Hasse diagram, Chains, Maximal and Minimal point. Glb, lub, Lattices and Algebraic system, Basic properties, Sublattices.	**10**
VII	**Boolean Algebra-** Basic definitions, Sum of products and products of sums, Boolean Functions, Disjunctive normal form, Complete Disjunctive normal form, conjugate normal form, Logic circuits, Logic networks, Design of circuits from given properties, Logic gates, and Karnaugh maps.	**9**
VIII	**Combinatorics-** Inclusion- exclusion, recurrence relations (nth order recurrence relation with constant coefficients, Homogeneous recurrence relations, Inhomogeneous recurrence relations), generating function (closed form expression, properties of G.F., solution of recurrence relations using G.F. solution of combinatorial problem using G.F.	**9**

Suggested Readings (Part-A Graph Theory):

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

Suggested Readings (Part-B Discrete Mathematics):

1. C. L. Liu., **Discrete Mathematics**, Tata McGraw Hill, 1986
2. Trembley and Manohar, **Discrete Mathematics with computer application**, Tata McGraw Hill, 2008
3. Kenneth H. Rosen, **Discrete Mathematics and Its Applications**, McGraw-Hill Companies, 2012
4. Suggested digital platform: NPTEL/SWAYAM/MOOCS

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

Suggested Continuous Evaluation Methods: Max. Marks: 25

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

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

Suggested equivalent online courses:

Further Suggestions:

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**

Part- B
Tensor Analysis

Unit	Topics	No. of Lectures
V	Tensor algebra: Vector spaces, the dual spaces, tensor product of vector spaces, transformation formulae, contraction, special tensors, symmetric tensor, inner product.	10
VI	Tensor Analysis: Contravariant and covariant vectors and tensors, Mixed tensors, Symmetric and skew-symmetric tensors, Algebra of tensors, Contraction and inner product, Q uotient theorem, Reciprocal tensors. Christoffel's symbols, Law of transformation of Christoffel's symbols,	10
VII	Gradient of scalars, Divergence of a contravariant vector, covariant vector and conservative vectors, Laplacian of an invariant, curl of a covariant vector.	9
VIII	Riemannian space, Riemannian curvatures and their properties, geodesics, geodesic curvature, geometrical interpretation of curvature tensor.	9

Suggested Readings (Part-A Differential Geometry):

1. T.J. Willmore, **An Introduction to Differential Geometry**, Dover Publications,2012.
2. B. O'Neill, **Elementary Differential Geometry**, 2nd Ed., Academic Press, 2006.
3. C.E. Weatherburn, **Differential Geometry of Three Dimensions**, Cambridge University Press 2003.
4. D.J. Struik, **Lectures on Classical Differential Geometry**, Dover Publications,1988.
5. S. Lang, **Fundamentals of Differential Geometry**, Springer,1999.
6. B. Spain, **Tensor Calculus: A Concise Course**, Dover Publications,2003.
7. L. P. Eisenhart, **An Introduction to Differential Geometry** (with the use of tensor Calculus), Princeton University Press,1940.
8. I. S. Sokolnikoff,**Tensor Analysis, Theory and Applications to Geometry and Mechanics of Continua**, 2nd Edition, John Wiley and Sons.,1964.
9. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Suggested Readings (Part-B Tensor Analysis):

1. Z. Ahsan, **Tensors- Mathematics of Differential Geometry,** PHI, 2015
2. David C. Kay, **Tensor Analysis, Schaum's Outline Series**, McGraw Hill 1988.
3. R. S, Mishra, **A Course in Tensors with Applications to Riemannian Geometry**, Pothishala Pvt. Ltd, 1965
4. Suggested digital platform: NPTEL/SWAYAM/MOOCS

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

Suggested Continuous Evaluation Methods: Max. Marks: 25

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

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

Suggested equivalent online courses:

Further Suggestions:

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**

Part- B
Complex Analysis

Unit	Topics	No. of Lectures
V	Functions of complex variable, Mappings; Mappings by the exponential function, Limits, Theorems on limits, Limits involving the point at infinity, Continuity, Derivatives, Differentiation formulae.	8
VI	Analytic Functions Cauchy-Riemann equations, Sufficient conditions for differentiability; Analytic functions and their examples, Harmonic function Method of constructing a regular function (Milne-Thomson's method).	8
VII	Conformal mapping, necessary and sufficient condition, Inverse point, Bilinear transformation, critical point, cross ratio, fixed point.	7
VIII	Exponential function, Logarithmic function, Branches and derivatives of logarithms, Trigonometric function, Derivatives of functions, Definite integrals of functions, Contours, Contour integrals and its examples, Upper bounds for moduli of contour integrals.	7

Suggested Readings (Part-A Metric Space):

1. M K Singal and A R Singal , **Topics in Analysis II** 2017
2. Shirali, Satish & Vasudeva, H. L., **Metric Spaces**, Springer, First Indian Print. 2009
3. Kumaresan, S., **Topology of Metric Spaces** Narosa Publishing House, 2014
4. Simmons, G. F. **Introduction to Topology and Modern Analysis,** Tata McGraw Hill. 2004
5. Suggested digital platform: NPTEL/SWAYAM/MOOCS.

Suggested Readings (Part-B Complex Analysis):

1. Shanti Narain , Function of Complex Variable, S Chand, 2005
2. S Ponnusamy, **Functions of Complex Analysis**, Narosa, 2005
3. Brown & Churchill, **Complex variable and applications,** 2013
4. Suggested digital platform: NPTEL/SWAYAM/MOOCS

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

Suggested Continuous Evaluation Methods: Max. Marks: 25

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

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

Suggested equivalent online courses:

Further Suggestions:

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**

PART-B

Operations Research

Unit	Topics	No. of Lectures
V	Operations research and its scope, Linear programming problems, statement and formation of general linear programming problems, graphical method, slack and surplus variables, standard and matrix forms of linear programming problem, basic feasible solution.	8
VI	Convex sets, fundamental theorem of linear programming, basic solution, Simplex method, introduction to artificial variables, two phase method Big-M method and their comparison.	8
VII	Resolution of degeneracy, duality in linear programming problems, primal dual relationships, revised simplex method.	7
VIII	Transportation problems, assignment problems.	7

Suggested Readings (Part-A Numerical Analysis):

1. MK. Jain, S.R.K. Iyengar & R.K. Jain, **Numerical Methods for Engineering and scientific computation,** New Age Publishers, 2009
2. S. S. Sastry, **Introductory methods of Numerical Analysis, PHI, 2012**
3. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Suggested Readings (Part-B Operations Research):

1.Taha, Hamdy H, **Operations Research- An Introduction**, Pearson Education. 2017

2.Hillier Frederick S and Lieberman Gerald J., **Introduction to Operations Research**, McGraw Hill Publication. 2012

3.Winston Wayne L., **Operations Research: Applications and Algorithms**, Cengage Learning, 4th Edition., 2004

4.Hira D.S. and Gupta Prem Kumar, **Problems in Operations Research**: Principles and Solutions, S Chand & Co Ltd., 1995

5.Suggested digital platform: NPTEL/SWAYAM/MOOCs.

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

Suggested Continuous Evaluation Methods: Max. Marks: 25

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

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

Suggested equivalent online courses:

Further Suggestions:

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)	

Suggested Readings:		
This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), Economics (UG/PG), B.Sc. (C.S.)		
Suggested Continuous Evaluation Methods: Max. Marks: 25		
SN	**Assessment Type**	**Max. Marks**
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment**	**5**
Course prerequisites: To study this course, a student must have Certificate Course in Applied Mathematics		
Suggested equivalent online courses:		
Further Suggestions:		

Appendix (परिशिष्ट)
भारतीय प्राचीन गणित और गणितज्ञों का परिचय,
सुझाए गए पाठ्यक्रम

(Introduction to Indian ancient Mathematics and Mathematicians- Suggested syllabus)

पाठ्यक्रम - 1 प्रथम वर्ष, (FIRST YEAR)

~मित्र तथा परम मित्र अंक (Friend and Fast Friend) -
सूत्र - निखिलम् नवतश्चरमं दशतः (Nikhilam Navatascharamam Dashatah)
~संकलन तथा व्यवकलन (Addition and subtraction)
सूत्र - एकन्यूनेन पूर्वेण तथा निखिलं नवतश्चरमं दशतः (Eknunen Purvena and Nikhilam Navatascharamam Dashatah)
~गुणन (Multiplication) -
एकाधिकेन पूर्वेण विधि (Ekadhikena Method)
एकन्यूनेन पूर्वेण विधि (Eknunen Purvena Method)
विचलन विधि (Deviation Method)
ऊर्ध्वतिर्यग्भ्याम् विधि (Vertically and Crosswise Method)
~संयुक्त संक्रिया (Mixed Operations)
निम्नलिखित भारतीय गणितज्ञों का योगदान (Contribution of the following Indian Mathematician)
~वराहमिहिर (Varahmihir)
~भास्कराचार्य (Bhaskaracharya)
~नीलकंठ सोमैया (Nilakantha Somaiya)
~श्रीधराचार्य (Sridharacharya)

पाठ्यक्रम - 2 द्वितीय वर्ष (SECOND YEAR)

~ विनकुलम संख्या, परिचय, रुपांतरण तथा अनुप्रयोग (Vinakulum number, Introduction, Conversion and Application)
भाग (Division)
~निखिलं विधि (Nikhilam Method)
~परावर्त्य विधि (Paravartya Method)
~ध्वजांक विधि (Flag Method)
विभाजकता की जांच (Test of Divisibility)
~लघुतम समापवर्त्य तथा महत्तम समापवर्तक (Least Common Multiple and Highest Common Factor)

निम्नलिखित भारतीय गणितज्ञों का योगदान (Contribution of the following Indian Mathematician)
~भारती कृष्ण तीर्थ (Bharti Krishna Tirtha)
~ब्रह्मगुप्त (Brahmagupta)
~महावीराचार्य (Mahaviracharya)
~श्रीनिवास रामानुजन (Srinivas Ramanujan)

पाठ्यक्रम - 3 तृतीय वर्ष (THIRD YEAR)

~द्वंद्वयोग (Duplex)
~वर्ग (Square)
~घन (Cube)
~वर्ग मूल (Square root)
~ घन मूल (Cube root)
~मूलांक - संकलन, व्यवकलन, गुणन तथा विभाजन की जांच (Digital root - Test of Addition, Subtraction, Multiplication and Division)

निम्नलिखित भारतीय गणितज्ञों का योगदान (Contribution of the following Indian Mathematician)
सी. आर. राव (C. R. RAO)
सत्येंद्र नाथ बोस (SATYENDRA NATH BOSE)
हेमचन्द्र(HEMCHANDRA)
शकुन्तला देवी(SHAKUNTALA DEVI)
मंजुल भार्गव(Manjul bhargav)

संदर्भ-ग्रंथ-सूची :-

(1) वैदिक गणित निर्देशिका भाग -1 तथा भाग - 2 विद्या भारती अखिल भारतीय शिक्षा संस्थान, कुरुक्षेत्र
(2) वैदिक गणित - मोतीलाल बनारसीदास, नई दिल्ली
(3) वैदिक गणित विहंगम दृष्टि - 1 शिक्षा संस्कृति उत्थान न्यास दिल्ली - डॉ. कैलाश विश्वकर्मा
(4) वैदिक गणित अतीत, वर्तमान एवं भविष्य शिक्षा संस्कृति उत्थान न्यास दिल्ली, डॉ. कैलाश विश्वकर्मा
(5) Vedic Mathematics for School (Vol. - 1) Vedic Mathematics Publication, Rakesh Bhatia
(6) Vedic Mathematics, Vedic Mathematics Publication, Rakesh Bhatia & Akshay Bhatia

(Dr. Shashi Sharma) (Dr. Kunwar Pal Singh) (Dr. Rishi Kumar Agarwal) (Prof. C.K Goel)

(Prof. R.C. Mittal) (Prof. Anil Vashistha) (Dr. Pramod Kumar Sahoo) (Prof. G.C. Sharma)

(Prof. M.K. Gupta) (Prof. Shiv Raj Singh)

Department of Higher Education
U.P. Government, Lucknow

National Education Policy-2020

Common Minimum Syllabus for all U.P. State Universities and Colleges For First Three Years of Higher Education

PROPOSED STRUCTURE OF UG CHEMISTRY SYLLABUS

VCO/23/279
22/06/21

(11)

(12)

Proceeding of Board of Studies in Chemistry

A meeting of the Board of Studies in Chemistry was held online on 29/5/2021. The following members were present :-

State Steering Committe Members for implementation of NEP2020

1. Prof. Vimala Y, Pro-VC, Chaudhary Charan Singh University, Meerut
2. Dr Dinesh Sharma, Ku Mayavati Govt College, Badalpur, UP

Members of the Board of Studies in Chemistry of Chaudhary Charan Singh University, Meerut

3. Prof. M.K. Gupta, Dean, Faculty of Science, Chaudhary Charan Singh Univeristy, Meerut
4. Prof. R. K. Soni, Department of Chemistry, Chaudhary Charan Singh Univeristy, Meerut
5. Dr. Gyanendrda Singh, M.M.H. College, Ghaziabad
6. Dr Sanjay Kumar Bhardwaj, SSV, Hapur
7. Prof. R. D. Kaushik, Dept of Chemistry, Gurukul Kangri University, Haridwar
8. Prof. S. K. Awasthi, Dept of Chemistry, University of Delhi
9. Prof. S. P.Singh, Emeritus Professor, Kurukshetra University, Kurkshetra
10. Dr. Sulekh Chandra, Retd Principal, Zakir Hussain College, University of Delhi
11. Prof Rajiv Jain, Director, Pondicherry University

The committee considered the syllabus prepared by committee constituted by the UP state Government was considered and discussed. The members of the state steering committee for implementation of NEP 2020 informed that this syllabus is minimum common syllabus is to be implemented in all the colleges and universities of the state. The committee considered the suggestions of the respected members of the committee and incorporated the same in the enclosed syllabus. The committee approved the syllabus for implementation in the affiliated colleges of the & Uttrakhand university from the session 2021-22 and onwards. The committee authorised the chairman and convenors to make petty changes if any required in near future.

(Prof. M. K. Gupta)
Dean
Faculty of Science

(Prof. R. K. Soni)
Convenor-I

Honourable VC

Sir, may kindly approve the proceedings & placing the syllabus approved by BOS on 29/5/21 before next Academic Council meeting.

29/5/21

Pro-VC/VC

22/6/21

National Education Policy-2020
Common Minimum Syllabus for all U.P. State Universities/ Colleges
SUBJECT: CHEMISTRY

Name	Designation	Affiliation
Steering Committee		
Mrs. Monika S. Garg, (I.A.S.) Chairperson Steering Committee	Additional Chief Secretary	Dept. of Higher Education U.P., Lucknow
Prof. Poonam Tandan	Professor, Dept. of Physics	Lucknow University, U.P.
Prof. Hare Krishna	Professor, Dept. of Statistics	CCS University Meerut, U.P.
Dr. Dinesh C. Sharma	Associate Professor, Dept. of Zoology	K.M. Govt. Girls P.G. College Badalpur, G.B. Nagar, U.P.
Supervisory Committee-Science Faculty		
Dr. Vijay Kumar Singh	Associate Professor, Dept. of Zoology	Agra College, Agra
Dr. Santosh Singh	Dean, Dept. of Agriculture	Mahatma Gandhi Kashi Vidhyapeeth, Varanasi
Dr. Baby Tabussam	Associate Professor, Dept. of Zoology	Govt. Raza P.G. College Rampur, U.P.
Dr. Sanjay Jain	Associate Professor, Dept. of Statistics	St. John's College, Agra

Syllabus Developed by:

S.No.	Name	Designation	Department	College/University
1.	Dr. Susan Verghese P	Associate Professor and Head	Chemistry	St. John's College, Agra
2.	Dr. Mohd Kamil Hussain	Assistant Professor	Chemistry	Govt. Raza P.G. College Rampur, U.P.
3.	Mrs. Neha Tripathee	Assistant Professor	Chemistry	Km. Mayawati Govt. Girls P.G. College, Badalpur, G.B. Nagar

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

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
Certificate in Bioorganic and Medicinal Chemistry					
1	I	B020101T	Fundamentals of Chemistry	Theory	4
		B020102P	Quantitative Analysis	Practical	2
	II	B020201T	Bioorganic and Medicinal Chemistry	Theory	4
		B020202P	Biochemical Analysis	Practical	2
Diploma in Chemical Dynamics and Analytical Techniques					
2	III	B020301T	Chemical Dynamics & Coordination Chemistry	Theory	4
		B020302P	Physical Analysis	Practical	2
	IV	B020401T	Quantum Mechanics and Analytical Techniques	Theory	4
		B020402P	Instrumental Analysis	Practical	2
Degree in Bachelor of Science					
3	V	B020501T	Organic Synthesis-A	Theory	4
		B020502T	Rearrangements and Chemistry of Group Elements	Theory	4
		B020503P	Qualitative Analysis	Practical	2
		B020504R	Research Project	Project	3
	VI	B020601T	Organic Synthesis-B	Theory	4
		B020602T	Chemical Energetics and Radiochemistry	Theory	4
		B020603P	Analytical Methods	Practical	2
		B020604R	Research Project	Project	3

Purpose of the Program

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

Program's Outcomes

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

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.

Subject: Chemistry							Total Credits of the subject
Year	Sem.	Theory Paper	Units	Practical Paper	Units	Research Project	
I	I	Fundamentals of Chemistry	1. Molecular polarity and Weak Chemical Forces 2. Simple Bonding theories of Molecules 3. Periodic properties of Atoms 4. Recapitulation of basics of Organic Chemistry 5. Mechanism of Organic Reactions 6. Stereochemistry 7. Basic Computer system (in brief) 8. Mathematical Concepts for Chemistry	Quantitative Analysis	1. Water Quality analysis 2. Estimation of Metals ions 3. Estimation of acids and alkali contents 4. Estimation of inorganic salts and hydrated water	Nil	4+2 = 6
	II	Bioorganic and Medicinal Chemistry	1. Chemistry of Carbohydrates 2. Chemistry of Proteins 3. Chemistry of Nucleic Acids 4. Introductory Medicinal Chemistry 5. Solid state 6. Introduction to Polymer 7. Kinetics and Mechanism of Polymerization 8. Synthetic Dyes	Biochemical Analysis	1. Qualitative and quantitative analysis of carbohydrates 2. Qualitative and quantitative analysis of Proteins, amino acids and Fats 3. Determination and identification of Nucleic Acids 4. Synthesis of simple drug molecules.	Nil	4+2 = 6
2	III	Chemical Dynamics & Coordination Chemistry	1. Chemical kinetics 2. Chemical Equilibrium 3. Phase Equilibrium 4. Kinetic theories of Gases 5. Liquid states 6. Coordination Chemistry 7. Theories of Coordination Chemistry 8. Inorganic Spectroscopy and Magnetism	Physical Analysis	1. Strengths of Solution 2. Surface tension and viscosity of pure liquids 3. Boiling point and Transition temperature 4. Phase Equilibrium	Nil	4+2 = 6
	IV	Quantum Mechanics and Analytical Techniques	1. Atomic Structure 2. Elementary Quantum Mechanics 3. Molecular Spectroscopy 4. UV-Visible Spectroscopy 5. Infrared Spectroscopy 6. ^{1}H-NMR Spectroscopy 7. Introduction to Mass Spectrometry 8. Separation Techniques	Instrumental Analysis	1. Molecular Weight Determination 2. Spectrophotometry 3. Spectroscopy 4. Chromatographic Separations	Nil	4+2 = 6
	V	Organic Synthesis-A	1. Alkane and Cycloalkanes 2. Alkenes 3. Alkynes 4. Arenes and Aromaticity 5. Alcohols	Qualitative Analysis	1. Inorganic Qualitative Analysis 2. Elemental analysis and identification of functional groups 3. Separation of organic Mixture 4. Identification of organic compounds	Research Project	4+4+2 +3 =13

			6. Phenols 7. Ethers and Epoxides 8. Organic Halides				
		Rearrangements and Chemistry of Group Elements	1. Rearrangements 2. Catalysis 3. Chemistry of the Main Group Elements 4. Chemistry of Transition Elements 5. Chemistry of Lanthanides 6. Chemistry of Actinides 7. Metal Carbonyls 8. Bioinorganic Chemistry				
	VI	Organic Synthesis-B	1. Reagents in Organic synthesis 2. Organometallic Compounds 3. Aldehydes and Ketones 4. Carboxylic acids and their Functional Derivatives 5. Organic Synthesis *via* Enolates 6. Organic Compounds of Nitrogen 7. Heterocyclic Compounds 8. Natural Products	Analytical Methods	1. Gravimetric Analysis 2. Paper Chromatography 3. Thin Layer Chromatography 4. Thermochemistry	Research Project	4+4+2 +3 =13
		Chemical Energetics and Radiochemistry	1. Thermodynamics-I 2. Thermodynamics-II 3. Electrochemistry 4. Ionic Equilibrium 5. Photo Chemistry 6. Colligative Properties of Solutions 7. Surface Chemistry 8. Radiochemistry				

COURSE		SUBJECT: CHEMISTRY					Total Credits of the subject
Year	Sem.	Paper Title		Prerequisite for paper	Elective For Major Subject	Hours per Semester	
Certificate in Bioorganic and Medicinal Chemistry	I	Theory-1	Fundamentals of Chemistry	Chemistry in 12th	Yes Open to all	60	4
		Practical 1	Quantitative Analysis	Chemistry in 12th	Yes Open to all	**60**	2
	II	Theoty-1	Bioorganic and Medicinal Chemistry	Passed Sem-I, Theory paper-1	**Yes** Zoo/Bot./Physics/ Math/Comp Sci	60	4
		Pracical-2	Biochemical Analysis	Opted Sem-II, Theory Ppaer-1	Yes Zoo/Bot./Physics/ Math/Comp Sci.	**60**	2
Diploma in Chemical Dynamics and Analytical Techniques	III	Theoty-1	Chemical Dynamics & Coordination Chemistry	Chemistry in 12th Physics in 12th	Yes Zoo/Bot./Physics/ Math/Comp Sci.	60	4
		Pracical-2	Physical Analysis	Opted Sem-III, Theory Ppaer-1	Yes Zoo/Bot./Physics/ Math/Comp Sci.	**60**	2
	IV	Theoty-1	Quantum Mechanics and Analytical Techniques	Chemistry in 12th	Yes Zoo/Bot./Physics/ Math/Comp Sci.	60	4
		Practical 2	Instrumental Analysis	Chemistry in 12th	Yes Zoo/Bot./Physics/ Math/Comp Sci.	**60**	2
Degree in Bachelor of Science	V	Theory-1	Organic Synthesis-A	Passed Sem-I, Theory paper	Yes Zoo/Bot./Physics/ Math/Comp Sci.	60	4
		Theory-1	Rearrangements and Chemistry of Group Elements	Passed Sem-I, Theory paper	Yes Zoo/Bot./Physics/ Math/Comp Sci.	60	4
		Practical 3	Qualitative analysis	Opted Sem-V Theory Ppaer-1 &2	Yes Zoo/Bot./Physics/ Math.	60	2

		Research Project	.....	.....	.....	45	3
	VI	Theory-1	Organic Synthesis-B	Passed Sem-V Theory paper-1	Yes Zoo/Bot./Physics/ Math	60	4
		Theory-1	Chemical Energetics and Radiochemistry	Chemistry in 12th Physics in 12th	Yes Zoo/Bot./Physics/ Math/Comp Sci.	60	4
		Practical 3	Analytical Methods	Chemistry in 12th	Yes Zoo/Bot./Physics/ Math/Comp Sci.	60	2
		Research Project	.....	.....	....	45	3

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
Certificate in Bioorganic and Medicinal Chemistry					
1	I	B020101T	Fundamentals of Chemistry	Theory	4
		B020102P	Quantitative Analysis	Practical	2
1	II	B020201T	Bioorganic and Medicinal Chemistry	Theory	4
		B020202P	Biochemical Analysis	Practical	2

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

	Molecular polarity and Weak Chemical Forces : Resonance and resonance energy, formal charge, Van der Waals forces, ion-dipole forces, dipole dipole interactions, induced dipole interaction, dipole moment and molecular Structure (Diatomic and polyatomic molecules), Percentage ionic character from dipole moment, polarizing power and polarizability. Fajan's rules and consequences of polarization. Hydrogen bonding, van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction.	
II	**Simple Bonding theories of Molecules** Atomic orbitals, Aufbau principle, multiple bonding (σ and π bond approach) and bond lengths, the valence bond theory (VBT), Concept of hybridization, hybrid orbitals and molecular geometry, Bent's rule, Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O, NH_3, PCl_5, SF_6, SF_4 ClF_3, I_3^-, and H_3O^+. Molecular orbital theory (MOT). Molecular orbital diagrams bond orders of homonuclear and heteronuclear diatomic molecules and ions (N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions)	10
III	**Periodic properties of Atoms (with reference to s & p-block):** Brief discussion, factors affecting and variation trends of following properties in groups and periods. Effective nuclear charge, shielding or screening effect, Slater rules, Atomic and ionic radii, Electronegativity, Pauling's/ Allred Rochow's scales, Ionization enthalpy, Electron gain enthalpy.	05
IV	**Recapitulation of basics of Organic Chemistry:** Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bonding, Van der Waals interactions, inclusion compounds, Clatherates, Charge transfer complexes, hyperconjugation, Dipole moment; Electronic Displacements: Inductive, electromeric, resonance mesomeric effects and their applications	05
V	**Mechanism of Organic Reactions:** Curved arrow notation, drawing electron movements with allows, half-headed and double-headed arrows, homolytic and heterolytic bond fission, Types of reagents – electrophiles and nucleophiles, Types of organic reactions, Energy considerations. Reactive intermediates – Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples).	10
VI	**Stereochemistry (To be taught with demonstration of Molecular models in the classroom teaching)-** Concept of isomerism, Types of isomerism; Optical isomerism – elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, disasteromers, threo and erythro diastereomers, meso compounds, resolution of enantionmer, inversion, retention and recemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometric isomerism – determination of configuration of geometric isomers, E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds. Conformational isomerism – conformational analysis of ethane and n-butane; conformations of cyclohexane, axial	10

	and equatorial bonds, conformation of **mono substituted cyclohexane** derivatives, Newman projection and Sawhorse formulae, Fischer and flying wedge formulae, Difference between configuration and conformation.	
VII	**Basic Computer system (in brief)**-Hardware and Software; Input devices, Storage devices, Output devices, Central Processing Unit (Control Unit and Arithmetic Logic Unit); Number system (Binary, Octal and Hexadecimal Operating System); Computer Codes (BCD and ASCII); Numeric/String constants and variables. Operating Systems (DOS, WINDOWS, and Linux); Introduction of Software languages: Low level and High Level languages (Machine language, Assembly language; QBASIC, FORTRAN) Software Products (Office, chemsketch, scilab, matlab, hyperchem, etc.), internet application.	05
VIII	**Mathematical Concepts for Chemistry** Logarithmic relations, curve sketching, linear graphs and calculation of slopes, differentiation of functions like Kx, e^x, X^n, sin x, log x; maxima and minima, partial differentiation and reciprocity relations, Integration of some useful/relevant functions; permutations and combinations, Factorials, Probability	05

Suggested Readings:

1. Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
2. Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education 2006.
3. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
4. Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.*, Oxford University Press, 1994.
5. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.
6. Singh J.,Yadav L.D.S.,Advanced Organic Chemistry,Pragati Edition
7. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
9. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
10. Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry*, 2nd edition, Oxford University Press, 2012.
11. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry*, John Wiley & Sons, Inc.
12. Sykes, P. *A guidebook to Mechanism in Organic Chemistry*, Pearson Education, 2003
13. Francis, **P. G.** Mathematics for Chemists, Springer, 1984
14. Mukeherji, Singh, Kapoor, Organic Chemistry , Vol 1, New Age International 2014
15. R.L.Madan, CHEMSITRY FOR DEGREE STUDENTS AS PER CBCS SEM 1, S Chand
16. Sonia Ratnani ,Shriniwas Gurjar | Sheetal Budhirajana, Chemistry (Inorganic & Organic) Volume-1, Manakin press
17. TN SRIVASTVA AND PC KAMPOJ, SYSTEMATIC NALYTICAL CHEMISTRY, SHOBAN LAL NAGIN CHAND

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggested online links:

http://heecontent.upsdc.gov.in/Home.aspx
https://nptel.ac.in/courses/104/106/104106096/
http://heecontent.upsdc.gov.in/Home.aspx
https://nptel.ac.in/courses/104/106/104106096/
https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm
https://nptel.ac.in/courses/104/103/104103071/#

This course is compulsory for the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others . **Or**	
Assessment and presentation of Assignment	(10 marks)
04 tests (Objective). Max marks of each test = 10 (average of all 04 tests)	(10 marks)
Overall performance throughout the semester, Discipline, participation in different activities)	(05 marks)
Course prerequisites: To study this course, a student must have had the chemistry in class 12th	
Suggested equivalent online courses:	
Further Suggestions:	

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

Suggested Readings:

1. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
2. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5. 3. Harris, D.C.*Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016. 4. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009. 5. Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Edition

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggestive digital platforms web links

6. https://www.labster.com/chemistry-virtual-labs/
7. https://www.vlab.co.in/broad-area-chemical-sciences
8. **http://chemcollective.org/vlabs**

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:	
Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

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

Suggested equivalent online courses:
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Further Suggestions:
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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

	acids, Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (**types of RNA**), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation	
IV	**Introductory Medicinal Chemistry** : Drug discovery, design and development; Basic Retrosynthetic approach. Drug action-receptor theory. Structure –activity relationships of drug molecules, binding role of –OH group,-NH_2 group, double bond and aromatic ring. Mechanism of action of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryl trinitrate), HIV-AIDS related drugs (AZT-Zidovudine	10
V	**Solid State** Definition of space lattice, unit cell. Laws of crystallography – (i) Law of constancy of interfacial angles, (ii) Law of rationality of indices and iii) Symmetry elements in crystals and law of symmetry .X-ray diffraction by crystals. Derivation of Bragg equation. Determination of crystal structure of NaCl, KCl and CsCl (powder method).	05
VI	**Introduction to Polymer** Monomers, Oligomers, Polymers and their characteristics, Classification of polymers : Natural synthetic, linear, cross linked and network; plastics, elastomers, fibres, Homopolymers and Co-polymers, Bonding in polymers : Primary and secondary bond forces in polymers ; cohesive energy, and decomposition of polymers. Determination of Molecular mass of polymers: Number Average molecular mass (Mn) and Weight average molecular mass (Mw) of polymers and determination by (i) Viscosity (ii) Light scattering method (iii) Gel permeation chromatography (iv) Osmometry and Ultracentrifuging. **Silicones and Phosphazenes** –Silicones and phosphazenes as examples of inorganic polymers, nature of bonding in triphosphazenes.	10
VII	**Kinetics and Mechanism of Polymerization** Polymerization techniques, Mechanism and kinetics of copolymerization,Addition or chain growth polymerization, Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler Natta polymerization and vinyl polymers, Condensation or step growth-polymerization, Polyesters, polyamides, phenol formaldehyde resins, urea formaldehyde resins, epoxy resins and polyurethanes.	05
VIII	**Synthetic Dyes:** Colour and constitution (electronic Concept), Classification of dyes, Chemistry and synthesis of Methyl orange, Congo red, Malachite green, crystal violet, phenolphthalein, fluorescein, Alizarin and Indigo.	05

Suggested Readings:

1. Davis, B. G., Fairbanks, A. J., *Carbohydrate Chemistry*, Oxford Chemistry Primer, Oxford University Press.
2. Finar, I. L. *Organic Chemistry (Volume 2)*, Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
3. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry 7th Ed.*, W. H. Freeman.
4. Berg, J. M., Tymoczko, J. L. & Stryer, L. *Biochemistry 7th Ed.*, W. H. Freeman.
5. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Patrick, G. L. Introduction to Medicinal Chemistry, Oxford University Press, UK, 2013.
7. Singh, H. & Kapoor, V.K. Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi, 2012.
8. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
9. Ball, D. W. Physical Chemistry Thomson Press, India (2007)
10. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
11. R.B. Seymour & C.E. Carraher: *Polymer Chemistry: An Introduction,* Marcel Dekker, Inc. New York, 1981.
12. G. Odian: *Principles of Polymerization*, 4th Ed. Wiley, 2004.
13. F.W. Billmeyer: *Textbook of Polymer Science*, 2nd Ed. Wiley Interscience, 1971.
14. P. Ghosh: Polymer Science & Technology, Tata McGraw-Hill Education, 1991
15. Mukherji, Singh , Kapoor, Organic Chemistry, Vol 3, New Age International
16. B.K.Sharma, Polymer Chemistry, Krishna Publications
17. J L Jain , Sunjay Jain & Nitin Jain, Fundamentals of Biochemistry, S. Chand Publishing
18. TN SRIVASTVA AND PC KAMPOJ, SYSTEMATIC NALYTICAL CHEMISTRY, SHOBAN LAL NAGIN CHAND

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University **Suggested online links:**

http://heecontent.upsdc.gov.in/Home.aspx
https://nptel.ac.in/courses/104/105/104105124/
https://nptel.ac.in/courses/103/106/105106204/
https://nptel.ac.in/courses/104/105/104105034/
https://nptel.ac.in/courses/104/103/104103121/
https://nptel.ac.in/courses/104/102/104102016/
https://nptel.ac.in/courses/104/106/104106106/
https://nptel.ac.in/courses/104/105/104105120/

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:

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-I, Theory paper-1

Suggested equivalent online courses:
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Further Suggestions:
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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

Suggested Readings:

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.*, Pearson (2012).
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education.
3. *Vogel's Qualitative Inorganic Analysis*, Revised by G. Svehla.
4. Vogel, A.I. *A Textbook of Quantitative Analysis*, ELBS. 1986
5. Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. *Vogel's Textbook of Practical Organic Chemistry*, ELBS.
6. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry,* Universities Pres 7. Cooper, T.G. Tool of Biochemistry. Wiley-Blackwell (1977).
8. Wilson, K. & Walker, J. Practical Biochemistry. Cambridge University Press (2009). **9.** Varley, H., Gowenlock, A.H & Bell, M.: Practical Clinical Biochemistry, Heinemann, **Note**: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University **Suggestive digital platforms web links**

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

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:

Viva voce	(10 marks)	
Mock test	(10 marks)	
Overall performance	(05marks)	

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

Suggested equivalent online courses:
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Further Suggestions:
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Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
Diploma in Chemical Dynamics and Analytical Techniques					
2	III	B020301T	Chemical Dynamics & Coordination Chemistry	Theory	4
		B020302P	Physical Analysis	Practical	2
	IV	B020401T	Quantum Mechanics and Analytical Techniques	Theory	4
		B020402P	Instrumental Analysis	Practical	2

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

IV	**Kinetic theories of gases** **Gaseous State:** Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waals equation of state. **Critical phenomena**: PV isotherms of real gases, continuity of states, the isotherms of Van der Waals equation, relationship between critical constants and Van der Waals constants, the law of corresponding states, reduced equation of state. **Molecular Velocities**: Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter.	10
V	**Liquid State** **Liquid State:** Intermolecular forces, structure of liquids (a qualitative description). Structural differences between solids, liquids and gases. Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholesterol phases. **Liquids in solids (gels)**: Classification, preparation and properties, inhibition, general application	5
VI	**Coordination Chemistry** Werner's theory of coordination complexes, classification of ligands, ambidentate ligands, chelates, coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo isomerism, geometrical and optical isomerism in square planar and octahedral complexes.	5
VII	**Theories of Coordination Chemistry** **I** Metal- ligand bonding in transition metal complexes, limitations of valance bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planner complexes, John teller effect, factors affecting the crystal-field parameters. II. Thermodynamic and kinetic aspects of metal complexes: A brief outline of thermodynamic stability of metal complexes, concept of hard and soft acids and bases and factors affecting the stability, stability constants of complexes and their determination, substitution reactions of square planar complexes	10
VIII	**Inorganic Spectroscopy and Magnetism** I)Electronic spectra of Transition Metal Complexes Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series, Orgel-energy level diagram for d1 and d9 states, discussion of the electronic spectrum of $[Ti(H_2O)_6]^{3+}$ complex ion. II)Magnetic properties of transition metal complexes, types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, correlation of μ_s and μ_{eff}	10

	values, orbital contribution to magnetic moments, application of magnetic moment data for 3d-metal complexes.	

Suggested Readings:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Cotton,F.A, Wilkinson,G and Gaus,P. L ,Basic Inorganic Chemistry,3rd Edition ,Wiley 1995
5. Lee,J.D, Concise Inorganic Chemistry 4th Edition ELBS,1977
6. Douglas,B, McDaniel ,D and Alexander,J ,Concepts of Models of Inorganic Chemistry, John Wiley & Sons; 3rd edition , 1994
7. Shriver,D.E Atkins,P.W and Langford,C .H , Inorganic Chemistry ,Oxford University Press, 1994.
8. Porterfield ,W.W, Inorganic Chemistry ,Addison Wesley 1984.
9. Sharpe,A .G, Inorganic Chemistry, ELBS,3RD edition ,1993
10. Miessler,G.L,Tarr,D.A, Inorganic Chemistry, 2nd edition , Prentice Hall,2001
11. Bahl and Bahl, Essential of Physical Chemistry, S.Chand
12. R Gopalan & V Ramalingam, Concise Coordination Chemistry, Vishal publishing house
13. TN SRIVASTVA AND PC KAMPOJ, SYSTEMATIC NALYTICAL CHEMISTRY, SHOBAN LAL NAGIN CHAND

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University **Suggestive digital platforms web links**

Suggestive digital platforms web links:

11. https://swayam.gov.in/
12. https://www.coursera.org/learn/physical-chemistry
13. https://www.mooc-list.com/tags/physical-chemistry
14. https://www.openlearning.com/courses/introduction-to-physical-chemistry/
15. https://www.my-mooc.com/en/categorie/chemistry
16. https://onlinecourses.swayam2.ac.in/nce19_sc15/preview
17. https://swayam.gov.in/
18. **https://www.coursera.org/browse/physical-science-and-engineering/chemistry**

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

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

Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	(05 marks)

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

Suggested equivalent online courses:

.....

Further Suggestions:

.....

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

	1. To study the effect of a solute (e.g. NaCl, succinic acid) on the critical solution temperature of two partially miscible liquids (e.g. phenolwater system) and to determine the concentration of that solute in the given phenol-water system 2. To construct the phase diagram of two component (e.g. diphenylamine – benzophenone) system by cooling curve method.	

Suggested Readings:

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

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University **Suggestive digital platforms web links**

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

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:	
Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

Course prerequisites: To study this course, a student must have Opted Sem-III, Theory Ppaer-1

Suggested equivalent online courses:

.....

Further Suggestions:

.....

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

	Schrödinger wave equation (time dependent and time independent) and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in a one dimensional box. Schrödinger wave equation for H-atom, separation into three equations (without derivation), quantum numbers and their importance, hydrogen like wave functions, radial wave functions, angular wave functions. Molecular orbital theory, basic ideas – Criteria for forming MO from AO, construction of MO by LCAO H_2^+ ion, calculation of energy levels from wave functions, physical picture of bonding and anti-bonding wave functions, concept of σ, σ^*, π, π^* orbitals and their characteristics.	
III	**Molecular Spectroscopy**: Introduction: Electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppenheimer approximation, degrees of freedom **Rotational Spectrum**:Diatomic molecules . Energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotor, isotope effect . **Vibrational Spectrum:** Infrared spectrum : Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups. **Raman spectrum:** Concept of polarizability , pure rotational and pure vibrational, Raman spectra of diatomic molecules, selection rules. Electronic Spectrum: Concept of potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules.	10
IV	**UV-Visible Spectroscopy :** Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules. Types of electronic transitions, λmax, chromophores and auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; application of Woodward Rules for calculation of λmax for the conjugated dienes: alicyclic, homoannular and heteroannular; extended conjugated systems distinction between cis and trans isomers (Cis and trans stilbene) .	5
V	**Infrared Spectroscopy:** **IR Spectroscopy**: Fundamental and non-fundamental molecular vibrations; Hooke's law selection rule, IR absorption positions of various functional groups (C=O, OH, NH, COOH and nitrile) , Effect of H-bonding, conjugation, resonance and ring size of cyclic ketones and lactones on IR absorptions; Fingerprint region and its significance; application in functional group analysis and and interpretation of I.R. spectra of simple organic compounds. Identification of the Carbonyl group in Ketones, Aldehydes, Carboxylic acids, Esters and Amides using IR Spectroscopy	5

VI	**^{1}H-NMR Spectroscopy (PMR)** NMR Spectroscopy: introduction; nuclear spin; NMR active molecules; basic principles of Proton Magnetic Resonance; choice of solvent and internal standard; equivalent and non-equivalent protons; chemical shift and factors influencing it; ring current effect; significance of the terms: up-/downfield, shielded and deshielded protons; spin coupling and coupling constant (1st order spectra); relative intensities of first-order multiplets: Pascal's triangle; chemical and magnetic equivalence in NMR ; anisotropic effects in alkene, alkyne, aldehydes and aromatics; NMR peak area, integration; relative peak positions with coupling patterns of common organic compounds; interpretation of NMR spectra of simple compounds. Applications of IR, UV and NMR spectroscopy for identification of simple organic molecules such as Ethanol, Ethyl acetate, acetone, acetaldehyde, dimethylformamide, Cis and trans 1,2-dimethyl cycloprpanone, propene, vinyl chloride, acetophenone, benzaldehyde, phenol, Toluene and ethyl benzene.	10
VII	**Introduction to Mass Spectrometry:** Principle of mass spectrometry, the mass spectrum, mass spectrometry diagram, molecular ion, metastable ion, fragmentation process, McLafferty rearrangement.	3
VIII	**Separation Techniques: Solvent** extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods.	07

Suggested Readings:

1. Alberty,R A, Physical Chemistry,4 th editionWiley Eastern Ltd ,2001.
2. Atkins,P W,the elements of physical chemistry,Oxford ,1991
3. Barrow,G .M,International student Edition .McGraw Hill, McGraw-Hill,1973.
4. Cotton,F.A, Wilkinson,G and Gaus,P. L ,Basic Inorganic Chemistry,3rd Edition ,Wiley 1995
5. Lee,J.D, Concise Inorganic Chemistry 4th Edition ELBS,1977
6. Clayden, J., Greeves, N., Warren, S., *Organic Chemistry,* Second edition, Oxford University Press 2012.
7. Silverstein, R. M., Bassler, G. C., Morrill, T. C. *Spectrometric Identification of Organic Compounds*, John Wiley and Sons, INC, Fifth edition.
8. Pavia, D. L. *et al. Introduction to Spectroscopy,* 5th Ed. Cengage Learning India Ed.
9. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
10. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
11. Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
12. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.
13. Mukherji, Singh,Kapoor, Organic Chemistry, Vol 1 and 2. New Age International 2014
14. RL Madan, CHEMSITRY FOR DEGREE STUDENTS ELECTIVE SEM V/VI AS PER CBS QUANTUM AND SPECTROSCOPY, S Chand Publishing
15. Y.R.Sharma, ELEMENTARY ORGANIC SPECTROSCOPY VOL 4, S Chand
16. GURDEEP RAJ, ADVANCED PHYSICAL CHEMSITRY, KRISHNA PUBLISHING
17. K.L.Kapoor, A Textbook of Physical Chemistry - Quantum Chemistry and Molecular Spectroscopy | Volume 4, Macmillan
18. TN SRIVASTVA AND PC KAMPOJ, SYSTEMATIC NALYTICAL CHEMISTRY, SHOBAN LAL NAGIN CHAND

Suggestive digital platforms web links

1. https://www.coursera.org/courses?query=chemistry&languages=en
2. https://www.mooc-list.com/tags/physical-chemistry
3. https://www.coursera.org/learn/physical-chemistry
4. https://ocw.mit.edu/courses/chemistry/5-61-physical-chemistry-fall-2017/
5. http://heecontent.upsdc.gov.in/Home.aspx
6. https://nptel.ac.in/courses/104/108/104108078/
7. https://nptel.ac.in/courses/104/108/104108124/
8. https://nptel.ac.in/courses/104/106/104106122/

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

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

Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	(05 marks)

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

Suggested equivalent online courses:

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Further Suggestions:

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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

	4. Determination of Biological oxygen demand (BOD).	
III	**Spectroscopy** 1. Assignment of labelled peaks in the IR spectrum of the same compound explaining the relative frequencies of the absorptions (C-H, O-H, N-H, C-O, C-N, C-X, C=C, C=O, N=O, C≡C, C≡N stretching frequencies; characteristic bending vibrations are included. Spectra to be provided). 2. Assignment of labelled peaks in the ^{1}H NMR spectra of the known organic compounds explaining the relative δ-values and splitting pattern. **3.** Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).	**10**
IV	**Chromatographic Separations** 1. Paper chromatographic separation of following metal ions: i. Ni (II) and Co (II) ii. Cu(II) and Cd(II) 2. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer Chromatography (TLC) 3. Separation and identification of the amino acids present in the given mixture by paper chromatography. Reporting the Rf values **4.** TLC separation of a mixture of dyes (fluorescein and methylene blue)	**20**

Suggested Readings:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.*, Pearson, 2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C.*Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009. 6. Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Edition.
7. Mikes, O. & Chalmes, R.A. *Laboratory Handbook of Chromatographic & AlliedMethods*, Elles Harwood Ltd. London.
8. Ditts, R.V. *Analytical Chemistry: Methods of separation*. Van Nostrand, New York, 1974. **Note**: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University **Suggestive digital platforms web links**

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

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:

Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

Course prerequisites: To study this course, a student must have had the chemistry in class
Suggested equivalent online courses: .....
Further Suggestions: .....

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
Degree in Bachelor of Science					
3	V	B020501T	Organic Synthesis-A	Theory	4
		B020502T	Rearrangements and Chemistry of Group Elements	Theory	4
		B020503P	Qualitative Analysis	Practical	2
		B020504R	Research Project	Project	3
	VI	B020601T	Organic Synthesis-B	Theory	4
		B020602T	Chemical Energetics and Radiochemistry	Theory	4
		B020603P	Analytical Methods	Practical	2
		B020604R	Research Project	Project	3

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

	addition to diene (conjugated dienes and allene); radical addition: HBr addition; mechanism of allylic and benzylic bromination in competition with brominations across C=C; use of NBS; interconversion of *E*- and *Z*- alkenes.	
III	**Chemistry of Alkynes** Methods of formation of alkynes, Addition to C≡C, mechanism, reactivity, regioselectivity and stereoselectivity; reactions: hydrogenation, halogenations, hydrohalogenation, hydration, oxymercuration demercuration, hydroboration-oxidation, dissolving metal reduction of alkynes (Birch); reactions of terminal alkynes by exploring its acidity; inter conversion of terminal and non terminal alkynes.	06
IV	**Aromaticity and Chemistry of Arenes** Nomenclature of benzene derivatives, MO picture of benzene, Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their Mechanism. Directing effects of the groups. Birch reduction, Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl, naphthalene and anthracene.	10
V	**Chemistry of Alcohols** Classification and nomenclature, Monohydric alcohols – nomenclature, methods of formation by reduction of Aldehydes, Ketones, Carboxylic acids and Esters, Hydrogen bonding, Acidic nature, Reactions of alcohols. Dihydric alcohols nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [Pb(OAc)4 and HIO_4] and pinacol pinacolone rearrangement. Trihydric alcohols - nomenclature, methods of formation, chemical reactions of glycerol.	8
VI	**Chemistry of Phenols** : Nomenclature, structure and bonding, preparation of phenols, physical properties and acidic character, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols – electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman syntheis, Hauben Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction	06
VII	**Chemistry of Ethers and Epoxides**: Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions – cleavage and autoxidation, Ziesel's method. Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.	05
VIII	**Chemistry of Organic Halides** Nomenclature and classes of alkyl halides, methods of formation, chemical reactions, Mechanisms of nucleophilic substitution reactions of alkyl halides, $SN^2$and SN^1reactions with energy profile	05

	diagrams; Polyhalogen compounds : Chloroform, carbon tetrachloride; Methods of formation of aryl halides, nuclear and side chain reactions; The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions; Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides, Synthesis and uses of DDT and BHC.	

Suggested Readings:

1. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 2. Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education, 2003.
3. Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012. 4. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
5. Clayden, J., Greeves, N. & Warren, S. *Organic Chemistry,* 2nd edition, Oxford University Press, 2012. 6. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry,* John Wiley & Sons, Inc.
7. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
8. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley \
9. Bariyar and Goyal , Organic Chemistry-II, Krishna Prakashan Media, Meerut , Third Edition, 2019
10. Mukherji, Singh, Kapoor, Organic Chemistry, volume 1,2 and 3, 2014, New Age International.
11. Geeta Rani, General Organic Chemistry , Manakin press
12. Arun Bahl & B S Bahl, Advanced Organic Chemistry, S. Chand Publishing
13. TN SRIVASTVA AND PC KAMPOJ, SYSTEMATIC NALYTICAL CHEMISTRY, SHOBAN LAL NAGIN CHAND

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University **Suggested online links:**

http://heecontent.upsdc.gov.in/Home.aspx
https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm
https://nptel.ac.in/courses/104/103/104103071/#
https://nptel.ac.in/courses/104/106/104106096/

This course is compulsory for the students of following subjects: Chemistry in 12th Class

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

Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	(05 marks)

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

Suggested equivalent online courses:
.....

Further Suggestions:
.....

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

	s-Block Elements: Comparative study, diagonal relationship, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, an introduction to alkyls and aryls. **p-Block Elements**: Comparative study (including diagonal relationship) of groups 13-17 elements, compounds like hydrides, oxides, oxyacids and halides of group 13-16, hydrides of boron-diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), tetrasulphur tetra nitride, basic properties of halogens, interhalogens and polyhalides. **Chemistry of Noble Gasses**: Chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon compounds.	
IV	**Chemistry of Transition Elements** **Chemistry of Elements of First Transition Series** -Characteristic properties of d-block elements. Binary compounds (hydrides, carbides and oxides) of the elements of the first transition series and complexes with respect to relative stability of their oxidation states, coordination number and geometry. **Chemistry of Elements of Second and Third Transition Series-** General characteristics, comparative treatment of Zr/Hf, Nb/Ta, Mo/W in respect of ionic radii, oxidation states, magnetic behavior, spectral properties and stereochemistry.	06
V	**Chemistry of Lanthanides** Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, ceric ammonium sulphate and its analytical uses.	4
VI	**Chemistry of Actinides** Electronic configuration, oxidation states and magnetic properties, chemistry of separation of Np, Pu and Am from U.	4
VII	**Metal Carbonyls** Metal carbonyls: 18-electron rule, preparation, structure and nature of bonding in the mononuclear and dinuclea carbonyls.	6
VIII	**Bioinorganic Chemistry** Essential and trace elements in biological processes, metalloporphyrins with special reference to heamoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to Ca^{2+}. Nitrogen fixation.	6

Suggested Readings:

1. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 2. Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education, 2003. 3. Carey, F. A., Guiliano, R. M.*Organic Chemistry,* Eighth edition, McGraw Hill Education, 2012. 4. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008. 5. Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry,* 2nd edition, Oxford University Press, 2012. 6. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry,* John Wiley & Sons, Inc. 7. Mukherji and Singh, Reaction Mechanism in Organic Chemistry, Laxmi Publications, 2016

7. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
8. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley.
9. Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
10. Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education 2006
11. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
12. Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.*, Oxford University Press, 1994.
13. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.
14. Francis, P. G. Mathematics for Chemists, Springer, 1984
15. Prakash Satya,Tuli G.D.,Basu S.K.Madan R.D.,Advanced inorganic Chemistry,S.Chand publishing.
16. Bariyar and Goyal , Inorganic Chemistry-II, Krishna Prakashan Media, Meerut , Third Eddition, 2019
17. PURI, SHARMA KALIA, Principles of Inorganic Chemistry, Shoban Lal Nagin Chand & Co.
18. R.D.Madan, Principles of Inorganic Chemistry, S CHAND PUBLISHERS
19. TN SRIVASTVA AND PC KAMPOJ, SYSTEMATIC NALYTICAL CHEMISTRY, SHOBAN LAL NAGIN CHAND

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggested online links:
http://heecontent.upsdc.gov.in/Home.aspx
https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm
https://nptel.ac.in/courses/104/103/104103071/#
https://swayam.gov.in/

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

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

Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	(05 marks)

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

Suggested equivalent online courses:
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Further Suggestions:
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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

Suggested Readings:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960. 5. Harris, D.C.*Exploring Chemical Analysis*, 9. Ed. New York, W.H. Freeman, 2016. 6. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009. **Note**: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggestive digital platforms web links

4. https://www.labster.com/chemistry-virtual-labs/
5. https://www.vlab.co.in/broad-area-chemical-sciences
1. **http://chemcollective.org/vlabs**

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:	
Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

Course prerequisites: To study this course, a student must have Opted Sem-V Theory Ppaer-1 &2

Suggested equivalent online courses:
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Further Suggestions:
.....

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

II	**Organometallic Compounds**-Organomagnesium compounds: the Grignard reagents, formation, structure and chemical reactions. Organozinc compounds: formation and chemical reactions. Organolithium compounds: formation and chemical reactions.	4
III	**Chemistry of Aldehydes and ketones:** Nomenclature and structure of the carbonyl groups, synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones uses 1, 3-dithianes, synthesis of ketones from nitrites and from carboxylic acids, Physical properties. Mechanism of nucleophillic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations, Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Oxidation of aldehydes, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, $LiAlH_4$ and $NaBH_4$ reductions. Halogenation of enolizable ketones An introduction to α, β unsaturated aldehydes and Ketones.	10
IV	**Carboxylic acids and their Functional Derivatives** Nomenclature and classification of aliphatic and aromatic carboxylic acids. Preparation and reactions. Acidity (effect of substituents on acidity) and salt formation, Reactions: Mechanism of reduction, substitution in alkyl or aryl group. Preparation and properties of dicarboxylic acids such as oxalic, malonic, succinic, glutaric, adipic and phthalic acids and unsaturated carboxylic acids such as acrylic, crotonic and cinnamic acids, Reactions: Action of heat on hydroxy and amino acids, and saturated dicarboxylic acids, stereospecific addition to maleic and fumaric acids. Preparation and reactions of acid chlorides, acid anhydrides, amides and esters, acid and alkaline hydrolysis of esters, trans-esterification.	8
V	**Organic Synthesis via Enolates** Acidity of α-hydrogens, alkylation of diethyl malonate and ethyl acetoacetate, Synthesis of ethyl acetoacetate: the Claisen condensation, Keto-enol tautomerism of ethyl acetoacetate. Alkylation of 1, 3-dithianes, Alkylation and acylation of enamines.	5
VI	**Organic Compounds of Nitrogen-** Preparation of nitroalkanes and nitroarenes, Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media, Picric acid. Halonitroarenes: reactivity, Structure and nomenclature of amines, physical properties, Stereochemistry of amines, Separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines. Amine salts as phase-transfer catalysts, Preparation of alkyl and aryl amines (reduction of nitro compounds, nitrities), reductive amination of aldehydic and ketonic compounds, Gabriel phthalimide reaction, Hofmann bromamide reaction. Reactions of amines, electrophilic aromatic	10

	substituton in aryl amines, reactions of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling	
VII	**Heterocyclic Chemistry** Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine, Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution, Mechanism of nucleophilic substitution reaction in pyridine derivatives, Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and six membered heterocycles, Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Nepieralski synthesis, Mechanism of electrophile substitution reactions of indole, quinoline and isoquinoline	10
VIII	**Natural Products** **Alkaloids & Terpenes:** Natural occurrence, General structural features, their physiological action, Hoffmann's exhaustive methylation, Emde's modification;. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine. Natural Occurrence and classification of terpenes, isoprene rule.	7

Suggested Readings:

17. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
18. Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education, 2003.
19. Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
20. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
21. Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry,* 2nd edition, Oxford University Press, 2012.
22. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry,* John Wiley & Sons, Inc.
23. Smith, J. G. *Organic Chemistry,* Tata McGraw-Hill Publishing Company Limited.
24. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley.
25. Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly& Sons (1976).
26. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
27. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural
28. Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
29. Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Pragati Prakashan (2010).
30. Organic Chemistry III, Krishna Prakashan Media, Meerut , Third Edition, 2019
31. Mukherji and Singh, Reaction Mechanism in Organic Chemistry, Laxmi Publications, 2016
32. Mukherji, Singh, Kapoor, Organic Chemistry, Vol 1,2,and 3, New Age International 2014
33. Arun Bahl & B S Bahl, Advanced Organic Chemistry, S. Chand Publishing
34. TN SRIVASTVA AND PC KAMPOJ, SYSTEMATIC NALYTICAL CHEMISTRY, SHOBAN LAL NAGIN CHAND

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University **Suggested online links:**

http://heecontent.upsdc.gov.in/Home.aspx
https://nptel.ac.in/courses/104/103/104103111/
https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm
https://nptel.ac.in/courses/104/103/104103071/#
https://swayam.gov.in/

This course compulsory for the students of following subjects: Chemistry in 12th Class

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

Or	
Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	(05 marks)
Course prerequisites: To study this course, a student must have 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

II	**Thermodynamics II** Second Law of Thermodynamics, Need for the law, different statements of the law, Carnot cycle and its efficiency. Carnot theorem. Thermodynamic scale of temperature. Concept of Entropy, Entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, Clausius inequality , entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases. Gibbs and Helmholtz Functions Gibbs function (G) and Helmhotz function (A) as thermodynamic quantities. A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, Variation of G and A with P, V and T. Third Law of Thermodynamics ; Nernst heat theorem , statement and concept of residual entropy. Nernst distribution law Thermodynamic derivation, applications .	10
III	**Electrochemistry**: Electrical transport:- Conduction in metals and in electrolyte solutions, specific conductance molar and equivalent conductance, measurement of equivalent conductance, variation of molar, equivalent and specific conductances with dilution. Migration of ions and Kohlrausch law , Arrhenius theory of electrolyte dissociation and its limitations. Weak and strong electrolytes . Ostwald's dilution law, its uses and limitations . Debye-Huckel-Onsager equation for strong electrolytes (elementary treatment only) . Transport number, definition and determination by Hittorf method and moving boundary method.	8
IV	**Ionic Equilibrium**: Electrode reactions, Nernst equation, derivation of cell EMF and single electrode potential, standard hydrogen electrode-reference electrodes and their applications, standard electrode potential, sign conventions, Electrolytic and Galvanic cells–Reversible and irreversible cells, conventional representation of electrochemical cells. EMF of a cell and its measurement. Definition of pH and pKa , determination of pH using hydrogen, quinhydrone and glass electrodes by potentiometric methods. Buffers – Mechanism of buffer action, Henderson-Hazel equation, application of buffer solution. Hydrolysis of salts	10
V	**Photo Chemistry:** Interaction of radiation with matter, difference between thermal and photochemical processes . Laws of photochemistry: Grothus- Drapper law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions – energy transfer processes (simple examples), kinetics of photochemical reaction.	04

VI	**Colligative Properties**-Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination, Osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure, Elevation of boiling point and depression of freezing, Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods for determining various colligative properties. Abnormal molar mass, Van't Hoff factor, Colligative properties of degree of dissociation and association of solutes.	6
VI I	**Surface Chemistry** **Adsorption**. Physical and chemical adsorption; Freundlich and Langmuir adsorption isotherms; multilayer adsorption and BET isotherm (no derivation required); Gibbs adsorption isotherm and surface excess; Heterogenous catalysis (single reactant); **Colloids**:Lyophobic and lyophilic sols, Origin of charge and stability of lyophobic colloids,Coagulation and Schultz-Hardy rule, Zeta potential and Stern double layer (qualitative idea), Tyndall effect; Electrokinetic phenomena (qualitative idea only); Stability of colloids and zeta potential; Micelle formation	07
VIII	**Radiochemistry** Natural and induced radioactivity; radioactive decay-a-decay, b-decay, g-decay; neutrom emission, positrom emission, electron capture; unit of radioactivity (Curie); half life period; Geiger-Nuttal rule, radioactive displacement law, radioactive series. Measurement of radioactivity: ionization chamber, Geiger counters, scintillation counters. Applications: energy tapping, dating of objects, neutron activation analysis, isotopic labelling studies, nuclear medicine-99mTc radiopharmaceuticals	07

Suggested Readings:

1. Foye, W.O., Lemke, T.L. & William, D.A.: Principles of Medicinal Chemistry, 4th ed., B..I. Waverly Pvt. Ltd. New Delhi.
2. Peter Atkins & Julio De Paula, Physical Chemistry 9th Ed., Oxford University Press (2010).
3. Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).
4. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
5. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
6. Castellan, G. W. Physical Chemistry 4th Edn. Narosa (2004).
7. Allen Bard ,J Larry . Faulkner R ,Fundamentals of Electrochemical methods –fundamentals and applications ,new York John ,Wiley & sons , 2001
8. H. J. Arnikar, *Essentials of Nuclear Chemistry*, 4th ed., New Age International, New Delhi, 1995.
9. Bariyar,and Goyal, Physical Chemistry-II, Krishna Prakashan Media, Meerut , Third Edition, 2019
10. TN SRIVASTVA AND PC KAMPOJ, SYSTEMATIC NALYTICAL CHEMISTRY, SHOBAN LAL NAGIN CHAND
11. KL KAPOOR, THERMODYNAMICS AND CHEMICAL EQUILIBRIUM VOL-2, Macmillan
12. Bahl and Bahl, Essential of physical chemsitry, S CHAND

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggested online links:

http://heecontent.upsdc.gov.in/Home.aspx
https://swayam.gov.in/
https://www.coursera.org/learn/physical-chemistry
https://www.mooc-list.com/tags/physical-chemistry
https://www.openlearning.com/courses/introduction-to-physical-chemistry/

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class	
Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others . **Or**	
Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	(05 marks)
Course prerequisites: To study this course, a student must have had the chemistry in class 12th , Physics in 12th	
Suggested equivalent online courses:	
Further Suggestions:	

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

	– ninhydrin. Separation of monosaccharides – a mixture of D- galactose and D -fructose using n- butanol: acetone: water (4:5:1). Spray reagent – aniline hydrogen phthalate	
III	**Thin Layer Chromatography** Determination of R*f* values and identification of organic compounds:Separation of green leaf pigments (spinach leaves may be used) Preparation of separation of 2,4-dinitrophenylhydrazones of acetone, 2-butanone, hexan-2, and 3-one using toluene and light petroleum (40:60) Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5)	8
IV	**Thermochemistry** 1. To determine the solubility of benzoic acid at different temperatures and to determine ΔH of the dissolution process 2. To determine the enthalpy of neutralization of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionization of the weak acid/weak base 3. To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born-Haber cycle	14

Suggested Readings:

1. Skoog .D.A., West.D.M and Holler .F.J., "Analytical Chemistry: An Introduction", 7th edition, Saunders college publishing, Philadelphia,(2010).
2. Larry Hargis.G" Analytical Chemistry: Principles and Techniques" Pearson©(1988) **Note**: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggestive digital platforms web links

4. https://www.labster.com/chemistry-virtual-labs/
5. https://www.vlab.co.in/broad-area-chemical-sciences
6. **http://chemcollective.org/vlabs**

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:

Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

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

Suggested equivalent online courses:
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Further Suggestions:
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