Maa Shakumbhari University, SAHARANPUR U.P.

माँ शाकुम्भरी विश्वविद्यालय, सहारनपुर, उत्तर प्रदेश

Syllabus of the Subject: Physics

For Four Year Undergraduate Programme

(As per guidelines of common minimum syllabus by U.P. Government according to National Education Policy-2020 amended with GO-2090/70-3-2024-09(01) Dated: 02-09-2024) w.e.f. session 2025-2026)

Members of the Board of Studies:

S. No.	Name	Signature
1.	Prof. Garima Jain, Dean Faculty of Science	
2.	Prof. Garima Jain, Convener	
4.	Prof. Ashok Kumar Dimri	
5.	Dr. Sanjay Kumar Singh	
6.	Prof. Beer Pal Singh, External Expert	
7.	Prof. R S Singh, External Expert	

SUBJECT: PHYSICS

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

Year	Sem.	Course code	Paper Title	Theory/ Practical	Credits
First Year	I	0120101	Mathematical Physics & Newtonian Mechanics	Theory	04
		0120180	Mechanical Properties of Matter	Practical	02
	II	0220101	Thermal Physics & Semiconductor Devices	Theory	04
		0220180	Thermal Properties of Matter & Electronic Circuits	Practical	02
Second Year	III	0320101	Electromagnetic Theory & Modern Optics	Theory	04
		0320180	Demonstrative Aspects of Electricity & Magnetism	Practical	02
	IV	0420101	Perspectives of Modern Physics & Basic Electronics	Theory	04
		0420180	Basic Electronics Instrumentation	Practical	02
		0420165	Research Project	Project	03
Third Year	V	0520101	Classical & Statistical Mechanics	Theory	04
		0520102	Quantum Mechanics & Spectroscopy	Theory	04
		0520180	Demonstrative Aspects of Optics & Lasers	Practical	02
	VI	0620101	Solid State & Nuclear Physics	Theory	04
		0620102	Analog & Digital Principles & Applications	Theory	04
		0620180	Analog & Digital Circuits	Practical	02

SEMESTER-WISE PAPER TITLES WITH DETAILS					
YEAR	SEMESTER	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 Bot./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 Bot./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 Bot./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 Bot./Chem./Comp. Sc./ Math. / Stat./Zool.
		Project	Research Project	Passed Sem III, Th Paper-1	YES Bot./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.

::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** Mathematical Physics & Newtonian Mechanics **(0120101)**	**Part A:** Basic Mathematical Physics **Part B:** Newtonian Mechanics & Wave Motion	04	60
			Practical Mechanical Properties of Matter **(0120180)**		02	60
		Second	**Theory** Thermal Physics & Semiconductor Devices **(0220101)**	**Part A:** Thermodynamics & Kinetic Theory of Gases **Part B:** Circuit Fundamentals & Semiconductor Devices	04	60
			Practical Thermal Properties of Matter & Electronic Circuits **(0220180)**		02	60
Diploma in Applied Physics with Electronics	II	Third	**Theory** Electromagnetic Theory & Modern Optics **(0320101)**	**Part A:** Electromagnetic Theory **Part B:** Physical Optics & Lasers	04	60
			Practical Demonstrative Aspects of Electricity & Magnetism **(0320180)**		02	60
		Fourth	**Theory** Perspectives of Modern Physics & Basic Electronics **(0420101)**	**Part A:** Perspectives of Modern Physics **Part B:** Basic Electronics & Introduction to Fiber Optics	04	60
			Research Project (0420165)		03	60
			Practical Basic Electronics Instrumentation **(0420180)**		02	60

Degree in Bachelor of Science	**III**	**Fifth**	**Theory** Classical & Statistical Mechanics **(0520101)**	**Part A:** Introduction to Classical Mechanics **Part B:** Introduction to Statistical Mechanics	04	60
			Theory Quantum Mechanics & Spectroscopy **(0520102)**	**Part A:** Introduction to Quantum Mechanics **Part B:** Introduction to Spectroscopy	04	60
			Practical Demonstrative Aspects of Optics & Lasers **(0520180)**		02	60
		Sixth	**Theory** Solid State & Nuclear Physics **(0620101)**	**Part A:** Introduction to Solid State Physics **Part B:** Introduction to Nuclear Physics	04	60
			Theory Analog & Digital Principles & Applications **(0620102)**	**Part A:** Analog Electronic Circuits **Part B:** Digital Electronics	04	60
			Practical Analog & Digital Circuits **(620180)**		02	60

Programme Class: **Certificate**	Year: **First**	Semester: **First**
Subject: **PHYSICS**		
Course Code: (0120101)	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: 33	
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:

8. Mathematical Physics, B. D. Gupta, S. Chand Publiction
9. Mathematical Physics, H. D. Das, S. Chand Publiction
10. Mechanics & Wave Motion, Agrawal, Jain & Sharma, Krishna Prakashan, Meeru

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 (CIE) of 25 marks shall be based on Class tests, assignments, presentations, etc. as per revised NEP guidelines.

- 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: (0120180)	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: **100**	Min. Passing Marks: 34

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 Evaluation Methods:

Evaluation of 100 marks shall be based on the experiments performed, viva-voce and lab records as per revised NEP guidelines (60+25+15).

One experiment of two hour duration is to be performed.

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

Further Suggestions:

- The institution may suggest a minimum number of experiments (say 6) to be performed by each student per semester from the Lab Experiment List.
- 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: (0220101)	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: 33

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
Circuit fundamentals & Basic Electronics, Agrawal, Jain & Sharma, Krishna Prakashan, Meerut 5.

Suggestive Digital Platforms / Web Links:

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

- National Programm 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 (CIE) of 25 marks shall be based on the class test, assignments, presentations, etc. as per revised NEP guidelines.

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

Programme Class: **Certificate**	Year: **First**	Semester: **Second**
Subject: **PHYSICS**		
Course Code: **0220180**	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: **100**	Min. Passing Marks: 34

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: Experiments based on measurement of L and C	60

	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/#

Suggested Evaluation Methods:

- Evaluation of 100 marks shall be based on the experiments performed, viva-voce and lab records as per revised NEP guidelines (60+25+15).
- One experiment of two hour duration is to be performed

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

Further Suggestions:

- The institution may suggest a minimum number of experiments (say 6) to be performed by each student per semester from the Lab Experiment List.
- 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: **0320101**	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: 33	
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).	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 Pub.

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 Internal Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on the class test, assignments, Presentations, etc. as per revised NEP guidelines.

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

Programme Class: **Diploma**	Year: **Second**	Semester: **Third**
Subject: **PHYSICS**		
Course Code: **0320180**	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: 100	Min. Passing Marks: 34	
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 Evaluation Methods:

- Evaluation of 100 marks shall be based on the experiments performed, viva-voce and lab records as per revised
- NEP guidelines (60+25+!5)
- One experiment of two hour duration is to be performed

The course is elective and can be opted by Botany / Chemistry / Computer Science / Mathematics / Statistics / Zoology

PREREQUISITE: Opted / Passed Semester III, Theory Paper-1

Further Suggestions:

- The institution may suggest a minimum number of experiments (say 6) to be performed by each student per semester from the Lab Experiment List.
- 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: **0420101**	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: 33	
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

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation (CIE) of 25 marks shall be based on the class test, assignments, Presentations, etc. as per revised NEP guidelines.

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

Programme/Class: **Diploma**	Year: Second	Semester: Fourth
Subject: **PHYSICS**		Credits: **03**
Course Code: **0420165**	Course Title: **RESEARCH PROJECT**	

Programme Class: **Diploma**	Year: **Second**	Semester: **Fourth**
Subject: **PHYSICS**		
Course Code: **0420180**	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: **100**	Min. Passing Marks: 34	
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 1. http://vlabs.iitkgp.ac.in/psac/#Diode as Clippers 2. Diode as Clampers 3. BJT as switch and Load Lines 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 Evaluation Methods:
Evaluation of 100 marks shall be based on the experiments performed, viva-voce and lab records as per revised NEP guidelines (60+25+15)
One experiment of two hour duration is to be performed

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

Further Suggestions:

- The institution may suggest a minimum number of experiments (say 6) to be performed by each student per semester from the Lab Experiment List.
- 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: **0520101**	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: 33	
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	**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.	7
	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 A

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 (CIE) of 25 marks shall be based on the class test, assignments, presentations, etc. as per revised NEP guidelines.

This course can be opted as an Elective by the students of Chemistry / Computer Science / Mathematics / Statistics

PREREQUISITE: Passed Semester I, Theory Paper 1

Programme Class: **Degree**	Year: **Third**	Semester: **Fifth**
Subject: **PHYSICS**		
Course Code: **0520102**	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: 33

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.

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 (CIE) of 25 marks shall be based on the class test, assignments, Presentations, etc. as per revised NEP guidelines.

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

Programme Class: **Degree**	Year: **Third**	Semester: **Fifth**
Subject: **PHYSICS**		
Course Code: **0520180**	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: **100**	Min. Passing Marks: 34

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 Evaluation Methods:

Evaluation of 100 marks shall be based on the experiments performed, viva-voce and lab records as per revised NEP guidelines (60+25+!5)
One experiment of two hour duration is to be performed

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

Further Suggestions:

- The institution may suggest a minimum number of experiments (say 6) to be performed by each student per semester from the Lab Experiment List.
- 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: **0620101**	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: 33	
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

1. Atomic and Nuclear Physics, Brij Lal, S. Chand Publication.
2. Nuclear Physics, S.N. Ghoshal, S. Chand Publication.
3. Atomic and Molecular Physics, Agarwal, Jain & Sharma, Krishna Prakashan.

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 (CIE) of 25 marks shall be based on the class test, assignments, presentations, etc. as per revised NEP guidelines.

- This course can be opted as an Elective by the students of Chemistry / Computer Science / Mathematics / Statistics
- **PREREQUISITE:** Passed Semester V, Theory Paper-2

<table>
<tr><td>Programme Class: Degree</td><td>Year: Third</td><td>Semester: Sixth</td></tr>
<tr><td colspan="3">Subject: PHYSICS</td></tr>
<tr><td>Course Code: 0620102</td><td colspan="2">Course title: Analog & Digital Principles & Applications</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>Credits: 4</td><td colspan="2">Core Compulsory / Elective</td></tr>
<tr><td>Max. Marks: 25+75</td><td colspan="2">Min. Passing Marks: 33</td></tr>
<tr><td colspan="3">Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0</td></tr>
<tr><td>Unit</td><td>Topics</td><td>No. of Lectures</td></tr>
<tr><td colspan="3">Part A: Analog Electronic Circuits</td></tr>
<tr><td>I</td><td>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.</td><td>9</td></tr>
<tr><td>II</td><td>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).</td><td>8</td></tr>
<tr><td>III</td><td>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</td><td>8</td></tr>
</table>

	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 (CIE) of 25 marks shall be based on the class test, assignments,

Presentations, etc. as per revised NEP guidelines.

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

Programme Class: **Degree**	Year: **Third**	Semester: **Sixth**
Subject: **PHYSICS**		
Course Code: **0620180**	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: 34
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 Evaluation Methods:

Evaluation of 100 marks shall be based on the experiments performed, viva-voce and lab records as per revised NEP guidelines (60+25+!5)

One experiment of two hour duration is to be performed

- The course can be opted by Botany / Chemistry / Computer Science / Mathematics / Statistics

PREREQUISITE: Opted / Passed Semester VI, Theory Paper-2

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: **Bachelor Degree (Honours)**	Year: 4	Semester: 7
Subject: **PHYSICS**		
Course Code: **0720101**	Course Title: **MATHEMATICAL PHYSICS**	

Course outcomes:

- Students will be able to solve the research problems based on the complex variables and integral of complex functions,
- Students will learn the solution of various mathematical equations using Laplace transformation.
- Students will be able to use of Fourier series and transformation in some spectroscopic analysis.
- The content given in 'Special functions and polynomials of this course will impart skills for direct employability.
- Students will understand the use of mathematical methods in their various branches of physics and engineering.

Credits: 4	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40

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

Unit	Topics	No. of Lectures
I	**Special functions and polynomials** Legendre, Hermite and Laguerre polynomials and their generating functions. Recurrence relations and special properties of $P_n(x)$ as solution of Legendre differential equation, Rodrigues formula, orthogonality of $P_n(x)$, associated Legendre polynomials (Introduction only). Bessel function of first kind, generating function, recurrence relations, $J_n(x)$ as solution of Bessel differential equation, Expansion of $J_n(x)$ when n is half and odd integer, Integral representation	20
II	**Complex Analysis:** Complex Variables, Function of a complex variable, Analytic Function, Cauchy Riemann conditions, Complex Integration, Cauchy's integral theorem Cauchy's integral formula, Taylor's and Laurent's Series (without derivation) Singularities, zeros and residue of complex function, Cauchy's Residue theorem, Evaluation of definite integrals of the type: $\int^{\infty} f(Sin\theta, Cos\theta)\, d\theta$, $\int^{\infty} f(x)\, dx$ and $\int^{\infty} f(x)e^{[illegible]}\, dx$ [illegible]	15
III	**Fourier Series and Fourier Integral:** Fourier series, Even and Odd function, Half range expansion, Function of arbitrary period, Physical applications of Fourier Series analysis, Fourier integral, Fourier integral for even and odd functions and its application.	10

IV	**Integral Transform** Laplace Transform, First and second shifting theorems, Inverse LT by partial fractions, LT of derivative and integral of a function, Solution of initial value problems by using LT Fourier Transform, Fourier Cosine Transform, Fourier Sine Transform, two dimensional and three-dimensional Fourier transform, Fourier Transform of delta and Gaussian function	15

Suggested Readings:

1. Kreyszig, E, "Advanced Engineering Mathematics" John Wiley & Sons.
2. Rajput, B.S., "Mathematical Physics" Pragati Prakashan, Meerut.
3. Das,H.K., "Mathematical Physics"

Suggestive digital platforms web links-

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on the class test, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: **Bachelor Degree (Honours)**	Year: 4	Semester: 7
Subject: **PHYSICS**		
Course Code: **0720102**	Course Title: **CLASSICAL MECHANICS**	

Course outcomes:

On the successful completion of classical mechanics, the students will be able to learn and understand the fundamental concepts of dynamics of the system of particles, related conservation theorems, equations of motion for mechanical systems using the Lagrangian and Hamiltonian formulation. The main course outcomes are as follows:

- Able to solve the mechanics of dynamical systems using Lagrange's equations of motion for conservative and non-conservative systems through Lagrangian formulation.
- Able to understand the variational principle and its application to solve mechanical problems using Lagrangian formulation.
- Able to deal with the problem of two bodies moving under the influence of a mutual central force motion.
- Able to understand the theory of small oscillations applied in many physical applications.
- Able to solve mechanical problems using Hamilton's equations of motion by Hamiltonian formulation.

Credits: 4	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0	

Unit	Topics	No. of Lectures
I	**Preliminaries:** Newtonian mechanics of a particle, Mechanics of a system of particles, Constraints; their classification, D'Alembert's principle, Virtual work, generalized coordinates and derivation of Lagrange's equations, Velocity-dependent potentials and the Dissipation function, Applications of Lagrangian formulation, Generalized velocity, momentum and energy, Cyclic coordinates, Symmetries of space and time with conservation laws.	15

II	**Variational Principles and Hamilton Formalism:** Hamilton's principle, some techniques of the calculus of variations, Derivation of Lagrange's equation from Hamilton's principle, advantages of variational principle formulation, Principle of least action, Legendre transformations and Hamilton equations of motion, Cyclic coordinates and conservation theorems, Canonical transformation generating functions, Properties, Poisson bracket, Poisson theorem, Relation of Poisson brackets, Hamilton Jacobi method.	15
III	**Two Body Central Force Problem:** Reduction to the equivalent one-body problem, Motion in a central force field, The Virial theorem, The inverse square law of force, The motion in central force in the Kepler problem.	15

IV	**Rigid Body Dynamics and Small oscillations:** Rotational motion, Moment of Inertia, Euler's theorem, Euler's Angles, Symmetric top, Concept of small oscillations, Expression of kinetic energy and potential energy for the problem of small oscillations, Frequencies of free vibration, and Normal coordinates.	15

Suggested Readings:

1. Goldstein, H., "Classical Mechanics"
2. Rana, N.C. & Joag P.S., "Classical Mechanics"
3. Sommerfield A., "Physics"
4. Perceival & Richards D., "Introduction to Dynamics"

Suggestive digital platforms web links-

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on the class test, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: **Bachelor Degree (Honours)**	Year: 4	Semester: 7
Subject: **PHYSICS**		
Course Code: **0720103**	Course Title: **QUANTUM MECHANICS - I**	

Course Outcomes:

- Students will be able to understand the physical and mathematical basis of quantum mechanics for non-relativistic systems.
- Students will be able to learn mathematical tools needed to develop the formal theory of quantum mechanics.
- Students will be able to understand the measurement process in quantum mechanics.
- Students will be able to understand the connection between measurement of results and the uncertainty relation.
- Students will be able to understand the application of wave function theory in quantum mechanics.
- Students will be able to appreciate the amazing power and surprises of quantum mechanics in problems like free particles and particles in a potential.
- Students will be able to recognize the applicability of angular momenta in several branches of physics.
- Students will be able to appreciate the profound strength of approximate methods in problems like Stark effect, Zeeman effect, etc.

Credits: 4	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0	

Unit	Topics	No. of Lectures
I	**Fundamental Concepts:** Schrodinger equations : Time dependent and time independent, Operators, Probability density, Expectation values, Principle of Superposition, Motion of wave packets, Eigen values and eigen vectors, Bound and continuum states, Postulates of Quantum mechanics, Coordinate and momentum representation, Hermitian operators, Degeneracy, Orthonormality and Completeness, Unitary Operators, Change of basis, Infinitesimal and finite unitary transformations, Commutator Algebra, Uncertainty relation between two operators, Free particle radial wave function, Spherical well, Cylindrical well, Charge particle in a magnetic field and Hydrogen atom.	20
II	**Representation and Transformations:** Hilbert Spaces, Vector and Bases, Dirac notation, Matrix representations of Kets, Bras and Operators, Matrix representation of Eigen value problem, Linear harmonic oscillator in matrix formulation, Space and time displacements, Rotation generators, Symmetry and conservation laws. Symmetric and anti-symmetric wave-functions and Pauli Exclusion Principle.	12
III	**Approximate Methods:** Time independent first and second order perturbation theory for non-degenerate and degenerate levels, Variational method, and its application for Helium atom,	14

	WKB Approximation. Application of electric field (Stark effect), normal and anomalous Zeeman Effect.	
IV	**Theory of Angular momentum:** Commutation relations involving angular momentum operators, the eigenvalue spectrum, Infinitesimal and finite rotations, Matrix representation of J, Addition of angular momentum, Clebsch- Gordon coefficients, Spin angular momentum, Spin wave functions, Pauli matrices, Precession of an electron in magnetic field, Addition of spin and orbital angular momentum.	14

Suggested Readings:

1. Liboff, R.L., "Introductory Quantum Mechanics".
2. Tyagi, I.S., "Principle of Quantum Mechanics".
3. Khare, S.P., "Quantum Mechanics and Atomic Physics".
4. Schiff, L.I., "Quantum Mechanics".
5. Zettili, N., "Quantum Mechanics: Concepts and Applications".
6. Griffiths, D.J., "Introduction to Quantum Mechanics".

Suggestive digital platforms web links-

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on the class test, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: **Bachelor Degree (Honours)**		Semester: 7
Subject: **PHYSICS**		
Course Code: **0720104**	Course Title: **ELECTRONIC DEVICES**	

Course Outcomes:

- To understand the conduction mechanism of elemental and compound semiconductors for designing the electronic components and circuits.
- Understanding the basic phenomenon of semiconductors, it can be used for the fabrication of modern devices.
- Having the knowledge of semiconductors, junction diodes, transistor biasing, feedback in amplifiers, students may perform better in competitive exams as well as may understand semiconductor and microelectronic Industries and find job opportunities in communication and telecommunication sectors also.

Credits: 4	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40

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

Unit	Topics	No. of Lectures
I	**Conduction Mechanism in Semiconductors:** Classification of semiconductors -Elemental and compound semiconductors, Direct band and indirect band gap semiconductors, The Fermi Level, Carrier concentrations; electron and hole concentrations at equilibrium, temperature dependence of carrier concentrations, degenerate semiconductors, drift of carriers in electric and magnetic fields; The Hall effect, conductivity and mobility, effect of temperature and doping on mobility,, Diffusion of carriers in semiconductors; generation and recombination, The continuity equation.	10
II	**Junction-diode and Bipolar Junction Transistors:** The Contact Potential and space charge region, Band diagram of P-N junction, Reverse bias breakdown, Zener diode, Tunnel diode. Metal semiconductor junction, Schottky diode. Transistor current components and parameters, Transistor CB, CE, CC configurations, Input output characteristics, Early Effect and base width modulation, Transistor load lines, Transistor as an amplifier, Graphical analysis of the CE configuration. Transistor biasing and thermal stabilization.	15

III	**Field Effect Transistors:** Construction and characteristics of JFET, transfer characteristics, The FET small signal model, Measurement of gm and rd, JFET fixed-bias, Self-bias and voltage divider configurations, JFET source follower (common-Drain configuration), JFET Common–Gate configuration, Depletion and enhancement type MOSFETs. Idea of NMOS, PMOS and CMOS.	15
IV	**Feedback in Amplifiers and Basics of Operational Amplifiers:** Feedback concept, Effect of negative feedback, Voltage-series feedback, Current-series feedback, Voltage-shunt feedback, Current-shunt feedback. Differential amplifier and its configurations, Op-Amp Block diagram, Schematic symbol and terminals of 741, D.C. power supplies for an Op-Amp, Ideal Op-Amp, Equivalent circuit of an Op-Amp, Important characteristics of an ideal Op-Amp, Practical Op-Amp characteristics, Ideal voltage transfer curve, Open loop operation of an Op-Amp. Op-Amp with negative feedback (closed loop configuration), concept of virtual short and virtual ground. Inverting and non-inverting amplifiers.	20

Suggested Readings:

1. Sze, S.M. & Kwok, K. Ng, "Physics of Semiconductor Devices".
2. Streetman, B.G., "Solid State Electronic Devices".
3. Boylestad, R.L. & Nashelsky, L., "Electronic Devices and Circuit Theory".
4. Millman, J. & Halkias, C.C., "Integrated Electronics".
5. Chattopadhyay, D & Rakshit, P. C., "Electronics Fundamental and Application".
6. Kumar, Balbir & Jain, S.B., "Electronic Devices and Circuits".

Suggestive digital platforms web links-

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2. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on the class test, assignments, presentations, etc. as per revised NEP guidelines.

<table>
<tr><td>Programme/Class: Bachelor Degree (Honours)</td><td>Year: 4</td><td>Semester: 7</td></tr>
<tr><td colspan="3">Subject: PHYSICS</td></tr>
<tr><td>Course Code: 0720180</td><td colspan="2">Course Title: PHYSICS LAB I</td></tr>
<tr><td colspan="3">Course Outcomes:
• At the end of the laboratory course, each student is expected to understand the basic concepts of electronics/nuclear physics through experiments.
• The students will get a better understanding of the concepts studied by them in the theory course and correlate with experimental observations.
• The student will gain practical knowledge of designing, assembling, and testing electronics circuits as well as understanding troubleshooting.
• The student would be equipped with an in-depth knowledge of Physics that can be applied in higher studies in every field of Physics.</td></tr>
<tr><td>Credits: 4</td><td colspan="2">Core Compulsory / Elective: Core Compulsory</td></tr>
<tr><td>Max. Marks: 100</td><td colspan="2">Min. Passing Marks: 40</td></tr>
<tr><td colspan="3">Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-8</td></tr>
</table>

List of Experiments-

Choose any **six** experiments from the given list.

1. To study the frequency response and to calculate the various parameters such as input Impedance, output impedance, current gain and voltage gain of the emitter follower.
2. To study the Drain characteristics and Mutual characteristics of a N/P channel MOSFET
3. To study the characteristics of a junction field effect transistor and to calculate the various parameters as

   (a)) drain dynamic resistance (b) mutual conductance (c) amplification factor
4. To study and compare the following transistor biasing techniques and calculate the Bias voltage and transistor currents in-

   (a) Single battery biasing (b) Two battery biasing (c) Voltage divider bias (d)Collector to base bias
5. To study the forward and reverse bias characteristics of the following diodes-

   (a) Germanium diode (b) Silicon diode (c) Zener diode (d) Light emitting diode
6. To study the characteristics of a P-N junction and determine –

   (a) Reverse saturation current (b) Material constant

   (c) Determination of temperature coefficient of the Junction (d) Junction voltage and energy band gap.
7. To study the diffraction pattern of a semiconductor laser and –

   a. Determine the width of the single slit from the diffraction pattern.

   b. Measure the thickness of the wire/obstacle.
   Determine the wavelength of the laser light using diffraction grating.

1. To study the absorption spectrum of iodine vapour and to obtain –

   (a) Energy level diagram for iodine molecule

   (b) Deducing the electronic excitation energy for iodine molecule

   (c) Deducing force constant for iodine molecule
2. To study the characteristics of a LED and –

   (a) Determination of Plank's constant (b) Determine the material constant

   (c) Determine the temperature coefficient

1. To study the characteristics of a Photocell and –

   (a) Determination of Plank's constant (b) Determine the material constant

   (c) Determine the temperature coefficient

11. To study a single stage R-C coupled amplifier cum feedback amplifier and draw its frequency Response curve and measure –

(a) Voltage/Power gain (b) Variation of gain (c) Input/Output Impedance

(d Phase relationship between input and output waveforms

12. To study a single stage L-C coupled amplifier cum feedback amplifier and draw its frequency response curve and measure –

(a) Voltage/Power gain (b)Variation of gain (c) Input/Output Impedance

(d) Phase relationship between input and output waveforms

13. To study the dielectric constant and determine the Curie temperature of the ferroelectric ceramics.

14. To demonstrate the concept of quantization of energy levels in accordance with the Bohr model of atoms by Frank Hertz experiment.

15. To trace a B-H curve for a ferro-magnetic material using CRO and to find magnetic parameters from The B-H curve

16. To calculate the resistivity of a semiconductor by Four-Probe method at different temperatures.

Suggested Evaluation Methods:

Evaluation of 100 marks shall be based on the experiments performed, viva-voce and lab records as per revised NEP guidelines (60+25+!5)

One experiment of four hour duration is to be performed

Programme/Class: **Bachelor Degree (Honours)**	Year: 4	Semester: 8
Subject: **PHYSICS**		
Course Code: **0820101**	Course Title: **STATISTICAL MECHANICS**	

Course Outcomes:

- After completion of the course, the students will have the basic knowledge of statistical mechanics.
- Students will be able to calculate the statistical quantities of various systems.
- Students will be able to explain the ensemble theory required for macroscopic properties of the matter in bulk in terms of its constituents.
- Students will understand the analysis of properties of ideal Bose gas, Bose- Einstein condensation, liquid helium and electron gas.
- Students will be able to understand the various theories and models of cluster expansion and fluctuations of thermodynamic variables.
- Students will have knowledge to explain theoretical aspects of order-disorder phase transition in various systems.

Credits: **4**	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40

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

Unit	Topics	No. of Lectures
I	**Ensembles and Statistics of Ideal Gas System:** Scope and objectives of statistical mechanics. Analysis of phase space, phase points, μ - space and γ - space, concept of ensemble, density of phase points, Microstates and Macrostates, Number of accessible microstates. Detailed analysis of micro-canonical, canonical and grand canonical ensembles. Partition function formulation. Partition function of microcanonical, canonical and grand canonical ensembles. The entropy of an ideal gas using microcanonical ensemble, Gibbs paradox, Sackur-Tetrode equation	15
II	**Quantum Statistical Mechanics:** Transition from classical statistical mechanics to quantum statistical mechanics. Postulates of quantum statistical mechanics, Density matrix, Indistinguishability and quantum statistics, identical particles and symmetry of wave functions. Basic postulate and particle distribution function of Bose Einstein statistics. Energy, number of particles and pressure of B.E. gas. Bose Einstein Condensation, Thermal properties of B.E. gas, Transition in liquid 4He, Superfluidity in 4He. Basic postulate and particle distribution function of Fermi Dirac statistics. Energy, number of particles, temperature and pressure of F.D. gas. Properties of ideal electron gas, Thermionic Emission	20

III	**Statistical models for order-disorder phase transition:** Cluster expansion for a classical gas, virial equation of state, first and second order phase transition, Ising model, mean-field and Heigenburg theories of Ising model, Exact solutions in one-dimension, Landau theory of phase transition, Landau theory of liquid Heical exponents.	15

IV	**Fluctuations:** Introduction to non-equilibrium process, mean square deviation, Energy and density fluctuations, one dimensional random walk, Random walk and Brownian motion, Langevin theory of Brownian motion and relation with diffusion equation, The Fokker-Plank equation	10

Suggested Readings:

1. Reif, F., "Statistical and Thermal Physics".
2. Huang, K., "Statistical Mechanics".
3. Pathria, R.K., "Statistical Mechanics".
4. Kubo, R., "Statistical Mechanics".
5. Landau & Lifshitz, "Statistical Physics".
6. Agarwal, B.K. & Eisner, M., "Statistical Mechanics".
7. Gopal, E.S.R., "Statistical Mechanics and properties of matter, theory and application"

Suggestive digital platforms web links-

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on the class test, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: **Bachelor Degree (Honours)**	Year: 4	Semester: 8
Subject: **PHYSICS**		
Course Code: **0820102**	Course Title: **ELECTRODYNAMICS**	

Course Objectives:

- To develop understanding of field produced by stationary charge distributions in free space, metals and dielectrics in students.
- To develop understanding of field produced by steady currents in free space and matter and different behavior of materials in magnetic field in students.
- To aware the students from time varying fields and fundamental equations of electromagnetism.
- To develop computational skills in students to solve basic problems of electromagnetism.
- To teach the students basic concepts in electromagnetic wave propagation in different media and at interfaces.

Course Outcomes:

After completing this course:

- Students will gain basic understanding of electrostatics, magnetostatics and electromagnetism.
- Students will become competent in solving basic problems of electromagnetism.
- Students will be in a position of critical questioning and answering in various situations of field and potential calculations.
- Students will be able to understand basic concepts of electromagnetic waves and their propagation in different media. This will, further, help them in understanding communication electronics in future.

Credits: 4	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0	

Unit	Topics	No. of Lectures
I	**Electrostatics:** Gauss' Law and its applications, divergence and Curl of E, Electrostatics of Conductors, Solution of electrostatic problems: Laplace's and Poisson's Equations, Methods of images, point charge near an infinite conducting plane, Point charge near a grounded conducting sphere, Electrostatic of Dielectrics: Dielectrics and Polarization, Field of polarized object, Electric field inside dielectrics, Electric displacement, Linear dielectrics.	15
II	**Magnetostatics:** Magnetic field of a Steady currents; Biot-Savart Law, Ampere's Law and elementary applications, Divergence and curl of B, Magnetic vector potential, Magnetostatic fields in Matter, Magnetization, field of a magnetized object, magnetic field inside matter, linear and nonlinear magnetic media; Ferromagnetism: Hysteresis loop.	15

III	**Time Varying Fields:** Faraday's laws of electromagnetic induction (Integral and Differential form), Maxwell's displacement current, Maxwell's equations in free space and dielectrics, Boundary conditions, Poynting theorem, Lienard Wiechert potentials due to a point charge, Field of a point charge in motion, Power radiated by accelerated charges.	15
IV	**Plane Electromagnetic Wave:** Electromagnetic waves in free space, dielectrics and conductors, Reflection and Refraction of EM Waves at an interface between dielectrics (normal and oblique incidence), transmission, absorption, Fresnel's relation of polarization by reflection and total internal reflection, Reflection from conducting surface.	15

Suggested Readings:

1. Jackson, J.D., "Classical Electrodynamics".
2. Reitz, J.R., Milford, F.J. & Christy, R.W., "Foundations of Electromagnetic Theory".
3. Griffiths, David J., "Introduction to Electrodynamics".
4. Verma, H.C., "Classical Electrodynamics".

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2. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on the class test, assignments, presentations, etc. as per revised NEP guidelines.

Programme /Class: **Bachelor Degree (Honours)**	Year: 4	Semester: 8
Subject: **PHYSICS**		
Course Code: **0820103**	Course Title: **ATOMIC AND MOLECULAR PHYSICS**	

Course Outcomes:

On successful completion of this course, the student will:

- Develop the ability to conceptually understand the atomic spectra of Hydrogen atoms and similar valence electron atoms.
- Be able to understand and interpret the atomic spectra for many electron atoms.
- Also, can explain the change in behavior of atoms in external applied electric and magnetic field and corresponding changes in observed spectra.
- Gain sufficient understanding of rotational, vibrational, electronic and Raman spectra of molecules.
- Develop skill in important material characterization techniques like IR/FTIR, Raman, etc.
- Acquire ability to apply Nuclear Magnetic Resonance (NMR) for structure elucidation of synthesized materials.
- The knowledge of various material characterization techniques will impart skills for direct employability.

Credits: 4	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0	

Unit	Topics	No. of Lectures
I	**Atomic Physics -I:** Introduction to Atomic spectra, Quantum states of an electron in Hydrogen atom. Relativistic corrections for energy levels of hydrogen atom. Concept of spin and fine structure of hydrogen atom. Singlet and triplet States of Helium. Broad features of spectra of alkali elements. Fine structure in Alkali Spectra.	15
II	**Atomic Physics - II:** Many electron atoms: Central field approximation, atomic wave function, Hartree and Hartree–Fock approximations, Results of Hartree's theory, Spectroscopic Terms: LS coupling, Lande Interval rule, determination of spectral terms for atoms; with two or more Non-equivalent optical electrons, and two or more equivalent optical electrons. Breit's scheme. JJ coupling for many electron atoms. Atom in external field, Zeeman, Paschen-Bach & Stark effects.	15
III	**Molecular Physics:** Born-Oppenheimer approximation, Classification of Molecules, Types of Molecular Spectra and Molecular Energy States: Pure Rotational Spectra, Vibrational-Rotational Spectra, Raman Scattering, Classical and Quantum theory of Raman effect. Selection rules, Isotope effect, Formation of electronic spectra, fine structure of electronic bands. Intensity distribution in electronic bands: Franck-Condon principle. Explanation of intensity distribution in absorption and emission bands from Franck-Condon principle.	20
IV	**Characterization Techniques:** Infrared/FTIR Spectroscopy, General description and working of dispersive and FTIR instrument. Interpretation of FTIR spectra. Raman spectroscopy. Nuclear Magnetic Resonance, Chemical Shift, NMR Spectrometer. NMR spectrum analysis. Magnetic Resonance, Chemical Shift, NMR Spectrometer. NMR spectrum analysis.	10

Suggested Readings:

1. White, H.E., "Introduction to atomic spectra".
2. Herzberg, "Spectra of diatomic molecules".
3. Weissbluth, M., "Atoms and Molecules".
4. Slater, "Quantum theory of Atomic Structure, Vol. 1".
5. Slater, "Quantum theory of Molecules and Solids".
6. Banwell, C.B., "Fundamentals of Molecular Spectroscopy".
7. Barrow, G.M., "Introduction to Molecular Spectroscopy".
8. Brown, J.M., "Molecular Spectroscopy".
9. Larkin, Peter J., "Infrared and Raman Spectroscopy: Principles and Special Interpretation".
10. Ghatak, Ajoy & Thyagarajan, K., "Lasers: Fundamentals and Applications".

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2. Swayam Prabha - DTH Channel,

   https://www.swayamprabha.gov.in/index.php/program/current_he/8

4. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on the class test, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: **Bachelor Degree (Honours)**	Year: 4	Semester: 8
Subject: **PHYSICS**		
Course Code: **0820104**	Course Title: **NUCLEAR AND PARTICLE PHYSICS**	

Course outcomes:

1. Students will be more enlightened with the study of nuclear Physics and ready to go for further study.
2. This course will be useful to understand different aspects of nuclear physics.
3. This course will give a better insight which will be a good boost for the students.
4. General introduction of nucleus with modern technology may open the Broadway of nucleus.

Credits: 4	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40

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

Unit	Topics	No. of Lectures
I	**General Introduction:** Scattering of α particles, Mirror nuclei, μ meson atoms consideration, Idea of protonic charged nuclear dimensions. Nuclear mass, Nuclear angular momentum and magnetic moment, electric quadrupole moment, Parity quantum number, Statistics of nuclear particles, Isobaric spin concept, Electron capture, Partial wave analysis of n-p scattering, phase shift, single and triplet potentials	15
II	**General β decay DISINTEGRATION:** Fermi theory of allowed β decay. Non conservation of parity and Wu's experiment, Internal conversion.	05
III	**Interaction and Detection of Nuclear Radiation with matter Chemical and Biological effects of radiation:** Interaction of charged particles with matter, Stopping power of heavy charged particles, Range and straggling of electrons. Introduction of Ionization chamber , Proportional counter ,G.M. counter ,scintillation counter . Radiation monitoring and Dosimeters, Physical effects of radiation, Chemical effects of radiation. Effects of radiation on water and aqueous solutions, Penetration and ionizing power of nuclear radiations in the human body.	18

IV	**Nuclear Models:** Single particle, Individual particle model, predictions of shell model and magic numbers.	05
V	**Nuclear elementary particles:** General idea of elementary particles, Conservation laws, CP and CPT invariance, introductions of hadrons, quarks, Gell-Mann Okubu mass formula, Formation of stars, Chandrashekhar limit, neutron rich matter and supernova explosion	07

Suggested Readings:

1. Srivastava, B.B., "Fundamentals of Nuclear Physics".
2. Ghoshal, S.N., "Nuclear Physics" S. Chand Publications.
3. Tayal, D.C., "Nuclear Physics" Himalaya Publications.

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3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on the class test, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: **Bachelor Degree (Honours)**	Year: 4	Semester: 8
Subject: **PHYSICS**		
Course Code: **0820180**	Course Title: **PHYSICS LAB II**	

Course Outcomes:

- At the end of the laboratory course, each and every student is expected to understand the basic concepts of electronics/nuclear physics through experiments.
- The students will get a better understanding of the concepts studied by them in the theory course and correlate with experimental observations.
- The student will gain practical knowledge of designing, assembling and testing electronics circuits as well as understanding troubleshooting.
- The student would be equipped with an in-depth knowledge of Physics that can be applied in higher studies in every field of Physics.

Credits: 4	Core Compulsory / Elective: Core Compulsory
Max. Marks: 100	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-8

List of Experiments-

Choose another **six** experiments from the given list.

1. To study the frequency response and to calculate the various parameters such as input Impedance, output impedance current gain and voltage gain of the emitter follower.
2. To study the Drain characteristics and Mutual characteristics of a N/P channel MOSFET
3. To study the characteristics of a junction field effect transistor and to calculate the various parameters as

   (a) drain dynamic resistance (b) mutual conductance (c) amplification factor

4. To study and compare the following transistor biasing techniques and calculate the Bias voltage and transistor currents in-

   (a) Single battery biasing (a) Two battery biasing (c) Voltage divider bias (d) Collector to base bias

5. To study the forward and reverse bias characteristics of the following diodes-

   (a) Germanium diode (b) Silicon diode (c) Zener diode (d) Light emitting diode

6. To study the characteristics of a P-N junction and determine –

   (a) Reverse saturation current (b) Material constant (c) Determination of temperature coefficient of the Junction (d) Junction voltage and energy band gap.

7. To study the diffraction pattern of a semiconductor laser and –

   (a) Determine the width of the single slit from the diffraction pattern.

   (b) Measure the thickness of the wire/obstacle.

(c) Determine the wavelength of the laser light using diffraction grating.

8. To study the absorption spectrum of iodine vapour and to obtain –
   (a) Energy level diagram for iodine molecule
   (b) Deducing the electronic excitation energy for iodine molecule
   (c) Deducing force constant for iodine molecule
9. To study the characteristics of a LED and –
   (a) Determination of Plank's constant (b) Determine the material constant
   (c) Determine the temperature coefficient
10. To study the characteristics of a Photocell and –
   (a) Determination of Plank's constant (b) Determine the material constant
   (c) Determine the temperature coefficient
11. To study a single stage R-C coupled amplifier cum feedback amplifier and draw its frequency response and measure –
   (a) Voltage/Power gain (b) Variation of gain (c) Input/Output Impedance
   (d) Phase relationship between input and output waveforms
12. To study a single stage L-C coupled amplifier cum feedback amplifier and draw its frequency response and measure –
   Voltage/Power gain (b) Variation of gain (c) Input/Output Impedance (d) Phase relationship between input and output waveforms
13. To study the dielectric constant and determine the Curie temperature of the ferroelectric ceramics.
14. To demonstrate the concept of quantization of energy levels in accordance with the Bohr model of atoms by Frank Hertz experiment.
15. To trace a B-H curve for a ferro-magnetic material using CRO and to find magnetic parameters from the B-H curve.
16. To calculate the resistivity of a semiconductor by Four-Probe method at different temperatures.

Suggested Evaluation Methods:
Evaluation of 100 marks shall be based on the experiments performed, viva-voce and lab records as per revised NEP guidelines (60+25+!5)
One experiment of four hour duration is to be performed

Programme/Class: **Bachelor Degree (Honours with Research)**	Year: 4	Semester: 7
Subject: **PHYSICS**		
Course Code: **0720101**	Course Title: **MATHEMATICAL PHYSICS**	

Course outcomes:

- Students will be able to solve the research problems based on the complex variables and integral of complex functions,
- Students will learn the solution of various mathematical equations using Laplace transformation.
- Students will be able to use of Fourier series and transformation in some spectroscopic analysis.
- The content given in 'Special functions and polynomials of this course will impart skills for direct employability.
- Students will understand the use of mathematical methods in their various branches of physics and engineering.

Credits: 4	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40

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

Unit	Topics	No. of Lectures
I	**Special functions and polynomials** Legendre, Hermite and Laguerre polynomials and their generating functions. Recurrence relations and special properties of $P_n(x)$ as solution of Legendre differential equation, Rodrigues formula, orthogonality of $P_n(x)$, associated Legendre polynomials (Introduction only). Bessel function of first kind, generating function, recurrence relations, $J_n(x)$ as solution of Bessel differential equation, Expansion of $J_n(x)$ when n is half and odd integer, Integral representation	20
II	**Complex Analysis:** Complex Variables, Function of a complex variable, Analytic Function, Cauchy Riemann conditions, Complex Integration, Cauchy's integral theorem Cauchy's integral formula, Taylor's and Laurent's Series (without derivation) Singularities, zeros and residue of complex function, Cauchy's Residue theorem, Evaluation of definite integrals of the type: $\int^{\cup\mho} f(Sin\theta, Cos\theta)\, d\theta$, $\int^{\cup\mho} f(x)\ dx$ and $\int^{\cup\mho} f(x)e^{\square\square} dx$ $\bar{\cup}\mho$ $\bar{\cup}\mho$ $\bar{\cup}\mho$	15
III	**Fourier Series and Fourier Integral:** Fourier series, Even and Odd function, Half range expansion, Function of arbitrary period, Physical applications of Fourier Series analysis, Fourier integral, Fourier integral for even and odd functions and its application.	10
IV	**Integral Transforms:**	15

	Laplace Transform, First and second shifting theorems, Inverse LT by partial fractions, LT of derivative and integral of a function, Solution of initial value problems by using LT Fourier Transform, Fourier Cosine Transform, Fourier Sine Transform, two dimensional and three-dimensional Fourier transform, Fourier Transform of delta and Gaussian function	

Suggested Readings:

4. Kreyszig, E, "Advanced Engineering Mathematics" John Wiley & Sons.

5. Rajput, B.S., "Mathematical Physics" Pragati Prakashan, Meerut.

6. Das,H.K., "Mathematical Physics"

Suggestive digital platforms web links-

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on the class test, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: **Bachelor Degree (Honours with Research)**	Year: 4	Semester: 7
Subject: **PHYSICS**		
Course Code: **072010165 in place of Classical Mechanics (0720102)**	Course Title: **RESEARCH PROJECT**	

Programme/Class: **Bachelor Degree (Honours with Research)**	Year: 4	Semester: 7
Subject: **PHYSICS**		
Course Code: **0720103**	Course Title: **QUANTUM MECHANICS - I**	

Course Outcomes:

- Students will be able to understand the physical and mathematical basis of quantum mechanics for non-relativistic systems.
- Students will be able to learn mathematical tools needed to develop the formal theory of quantum mechanics.
- Students will be able to understand the measurement process in quantum mechanics.
- Students will be able to understand the connection between measurement of results and the uncertainty relation.
- Students will be able to understand the application of wave function theory in quantum mechanics.
- Students will be able to appreciate the amazing power and surprises of quantum mechanics in problems like free particles and particles in a potential.
- Students will be able to recognize the applicability of angular momenta in several branches of physics.
- Students will be able to appreciate the profound strength of approximate methods in problems like Stark effect, Zeeman effect, etc.

Credits: 4	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0	

Unit	Topics	No. of Lectures
1	**Fundamental Concepts:** Schrodinger equations : Time dependent and time independent, Operators, Probability density, Expectation values, Principle of Superposition, Motion of wave packets, Eigen values and eigen vectors, Bound and continuum states, Postulates of Quantum mechanics, Coordinate and momentum representation, Hermitian operators, Degeneracy, Orthonormality and Completeness, Unitary Operators, Change of basis, Infinitesimal and finite unitary transformations, Commutator Algebra, Uncertainty relation between two operators, Free particle radial wave function, Spherical well, Cylindrical well, Charge particle in a magnetic field and Hydrogen atom.	20

II	**Representation and Transformations:** Hilbert Spaces, Vector and Bases, Dirac notation, Matrix representations of Kets, Bras and Operators, Matrix representation of Eigen value problem, Linear harmonic oscillator in matrix formulation, Space and time displacements, Rotation generators, Symmetry and conservation laws. Symmetric and anti-symmetric wave-functions and Pauli Exclusion Principle.	12
III	**Approximate Methods:** Time independent first and second order perturbation theory for non-degenerate and degenerate levels, Variational method, and its application for Helium atom, WKB Approximation. Application of electric field (Stark effect), normal and anomalous Zeeman Effect.	14
IV	**Theory of Angular momentum:** Commutation relations involving angular momentum operators, the eigenvalue spectrum, Infinitesimal and finite rotations, Matrix representation of J, Addition of angular momentum, Clebsch- Gordon coefficients, Spin angular momentum, Spin wave functions, Pauli matrices, Precession of an electron in magnetic field, Addition of spin and orbital angular momentum.	14

Suggested Readings:

7. Liboff, R.L., "Introductory Quantum Mechanics".
8. Tyagi, I.S., "Principle of Quantum Mechanics".
9. Khare, S.P., "Quantum Mechanics and Atomic Physics".
10. Schiff, L.I., "Quantum Mechanics".
11. Zettili, N., "Quantum Mechanics: Concepts and Applications".
12. Griffiths, D.J., "Introduction to Quantum Mechanics".

Suggestive digital platforms web links-

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on the class test, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: **Bachelor Degree (Honours with Research)**	Year: 4	Semester: 7
Subject: **PHYSICS**		
Course Code: **0720104**	Course Title: **ELECTRONIC DEVICES**	

Course Outcomes:

- To understand the conduction mechanism of elemental and compound semiconductors for designing the electronic components and circuits.
- Understanding the basic phenomenon of semiconductors, it can be used for the fabrication of modern devices.
- Having the knowledge of semiconductors, junction diodes, transistor biasing, feedback in amplifiers, students may perform better in competitive exams as well as may understand semiconductor and microelectronic Industries and find job opportunities in communication and telecommunication sectors also.

Credits: **4**	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40

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

Unit	Topics	No. of Lectures
I	**Conduction Mechanism in Semiconductors:** Classification of semiconductors -Elemental and compound semiconductors, Direct band and indirect band gap semiconductors, The Fermi Level, Carrier concentrations; electron and hole concentrations at equilibrium, temperature dependence of carrier concentrations, degenerate semiconductors, drift of carriers in electric and magnetic fields; The Hall effect, conductivity and mobility, effect of temperature and doping on mobility,, Diffusion of carriers in semiconductors; generation and recombination, The continuity equation.	10
II	**Junction-diode and Bipolar Junction Transistors:** The Contact Potential and space charge region, Band diagram of P-N junction, Reverse bias breakdown, Zener diode, Tunnel diode. Metal semiconductor junction, Schottky diode. Transistor current components and parameters, Transistor CB, CE, CC configurations, Input output characteristics, Early Effect and base width modulation, Transistor load lines, Transistor as an amplifier, Graphical analysis of the CE configuration. Transistor biasing and thermal stabilization.	15

III	**Field Effect Transistors:** Construction and characteristics of JFET, transfer characteristics, The FET small signal model, Measurement of gm and rd, JFET fixed-bias, Self-bias and voltage divider configurations, JFET source follower (common-Drain configuration), JFET Common–Gate configuration, Depletion and enhancement type MOSFETs. Idea of NMOS, PMOS and CMOS.	15
IV	**Feedback in Amplifiers and Basics of Operational Amplifiers:** Feedback concept, Effect of negative feedback, Voltage-series feedback, Current-series feedback, Voltage-shunt feedback, Current-shunt feedback. Differential amplifier and its configurations, Op-Amp Block diagram, Schematic symbol and terminals of 741, D.C. power supplies for an Op-Amp, Ideal Op-Amp, Equivalent circuit of an Op-Amp, Important characteristics of an ideal Op-Amp, Practical Op-Amp characteristics, Ideal voltage transfer curve, Open loop operation of an Op-Amp. Op-Amp with negative feedback (closed loop configuration), concept of virtual short and virtual ground. Inverting and non-inverting amplifiers.	20

Suggested Readings:

7. Sze, S.M. & Kwok, K. Ng, "Physics of Semiconductor Devices".
8. Streetman, B.G., "Solid State Electronic Devices".
9. Boylestad, R.L. & Nashelsky, L., "Electronic Devices and Circuit Theory".
10. Millman, J. & Halkias, C.C., "Integrated Electronics".
11. Chattopadhyay, D & Rakshit, P. C., "Electronics Fundamental and Application".
12. Kumar, Balbir & Jain, S.B., "Electronic Devices and Circuits".

Suggestive digital platforms web links-

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on the class test, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: **Bachelor Degree (Honours with Research)**	Year: 4	Semester: 7
Subject: **PHYSICS**		
Course Code: **0720180**	Course Title: **PHYSICS LAB I**	

Course Outcomes:

- At the end of the laboratory course, each student is expected to understand the basic concepts of electronics/nuclear physics through experiments.
- The students will get a better understanding of the concepts studied by them in the theory course and correlate with experimental observations.
- The student will gain practical knowledge of designing, assembling, and testing electronics circuits as well as understanding troubleshooting.
- The student would be equipped with an in-depth knowledge of Physics that can be applied in higher studies in every field of Physics.

Credits: 4	Core Compulsory / Elective: Core Compulsory
Max. Marks: 100	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-8	

List of Experiments-

Choose any **six** experiments from the given list.

1. To study the frequency response and to calculate the various parameters such as input Impedance, output impedance, current gain and voltage gain of the emitter follower.
2. To study the Drain characteristics and Mutual characteristics of a N/P channel MOSFET
3. To study the characteristics of a junction field effect transistor and to calculate the various parameters as

   (a)) drain dynamic resistance (b) mutual conductance (c) amplification factor
4. To study and compare the following transistor biasing techniques and calculate the Bias voltage and transistor currents in-

   (a) Single battery biasing (b) Two battery biasing (c) Voltage divider bias (d)Collector to base bias
5. To study the forward and reverse bias characteristics of the following diodes-

   (a) Germanium diode (b) Silicon diode (c) Zener diode (d) Light emitting diode
6. To study the characteristics of a P-N junction and determine –

   (a) Reverse saturation current (b) Material constant

   (c) Determination of temperature coefficient of the Junction (d) Junction voltage and energy band gap.
7. To study the diffraction pattern of a semiconductor laser and –

   a. Determine the width of the single slit from the diffraction pattern.

   b. Measure the thickness of the wire/obstacle.

(c) Determine the wavelength of the laser light using diffraction grating.

8. To study the absorption spectrum of iodine vapour and to obtain –

(b) Energy level diagram for iodine molecule

(c) Deducing the electronic excitation energy for iodine molecule

(d) Deducing force constant for iodine molecule

9. To study the characteristics of a LED and –

(e) Determination of Plank's constant (b) Determine the material constant

(c) Determine the temperature coefficient

10. To study the characteristics of a Photocell and –

(b) Determination of Plank's constant (b) Determine the material constant

(c) Determine the temperature coefficient

11. To study a single stage R-C coupled amplifier cum feedback amplifier and draw its frequency Response curve and measure –

(a) Voltage/Power gain (b) Variation of gain (c) Input/Output Impedance

(d Phase relationship between input and output waveforms

12. To study a single stage L-C coupled amplifier cum feedback amplifier and draw its frequency response curve and measure –

(a) Voltage/Power gain (b)Variation of gain (c) Input/Output Impedance

(d) Phase relationship between input and output waveforms

13. To study the dielectric constant and determine the Curie temperature of the ferroelectric ceramics.

14. To demonstrate the concept of quantization of energy levels in accordance with the Bohr model of atoms by Frank Hertz experiment.

15. To trace a B-H curve for a ferro-magnetic material using CRO and to find magnetic parameters from The B-H curve

16. To calculate the resistivity of a semiconductor by Four-Probe method at different temperatures.

Suggested Evaluation Methods:

Evaluation of 100 marks shall be based on the experiments performed, viva-voce and lab records as per revised NEP guidelines (60+25+15)
One experiment of four hour duration is to be performed

Programme/Class: **Bachelor Degree (Honours with Research)**	Year: 4	Semester: 8
Subject: **PHYSICS**		
Course Code: **0820165 in place of Statistical Mechanics (0820101)**	Course Title: **RESEARCH PROJECT**	

Programme/Class: **Bachelor Degree (Honours with Research)**	Year: 4	Semester: 8
Subject: **PHYSICS**		
Course Code: **0820102**	Course Title: **ELECTRODYNAMICS**	

Course Objectives:

- To develop understanding of field produced by stationary charge distributions in free space, metals and dielectrics in students.
- To develop understanding of field produced by steady currents in free space and matter and different behavior of materials in magnetic field in students.
- To aware the students from time varying fields and fundamental equations of electromagnetism.
- To develop computational skills in students to solve basic problems of electromagnetism.
- To teach the students basic concepts in electromagnetic wave propagation in different media and at interfaces.

Course Outcomes:

After completing this course:

- Students will gain basic understanding of electrostatics, magnetostatics and electromagnetism.
- Students will become competent in solving basic problems of electromagnetism.
- Students will be in a position of critical questioning and answering in various situations of field and potential calculations.
- Students will be able to understand basic concepts of electromagnetic waves and their propagation in different media. This will, further, help them in understanding communication electronics in future.

Credits: 4	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0	

Unit	Topics	No. of Lectures
I	**Electrostatics:** Gauss' Law and its applications, divergence and Curl of E, Electrostatics of Conductors, Solution of electrostatic problems: Laplace's and Poisson's Equations, Methods of images, point charge near an infinite conducting plane, Point charge near a grounded conducting sphere, Electrostatic of Dielectrics: Dielectrics and Polarization, Field of polarized object, Electric field inside dielectrics, Electric displacement, Linear dielectrics.	15

II	**Magnetostatics:** Magnetic field of a Steady currents; Biot-Savart Law, Ampere's Law and elementary applications, Divergence and curl of B, Magnetic vector potential, Magnetostatic fields in Matter, Magnetization, field of a magnetized object, magnetic field inside matter, linear and nonlinear magnetic media; Ferromagnetism: Hysteresis loop.	15
III	**Time Varying Fields:** Faraday's laws of electromagnetic induction (Integral and Differential form), Maxwell's displacement current, Maxwell's equations in free space and dielectrics, Boundary conditions, Poynting theorem, Lienard Wiechert potentials due to a point charge, Field of a point charge in motion, Power radiated by accelerated charges.	15
IV	**Plane Electromagnetic Wave:** Electromagnetic waves in free space, dielectrics and conductors, Reflection and Refraction of EM Waves at an interface between dielectrics (normal and oblique incidence), transmission, absorption, Fresnel's relation of polarization by reflection and total internal reflection, Reflection from conducting surface.	15

Suggested Readings:

5. Jackson, J.D., "Classical Electrodynamics".

6. Reitz, J.R., Milford, F.J. & Christy, R.W., "Foundations of Electromagnetic Theory".

7. Griffiths, David J., "Introduction to Electrodynamics".

8. Verma, H.C., "Classical Electrodynamics".

Suggestive digital platforms web links-

4. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx

5. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

6. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on the class test, assignments, presentations, etc. as per revised NEP guidelines.

Programme /Class: **Bachelor Degree (Honours with Research)**	Year: 4	Semester: 8
Subject: **PHYSICS**		
Course Code: **0820103**	Course Title: **ATOMIC AND MOLECULAR PHYSICS**	

Course Outcomes:

On successful completion of this course, the student will:

- Develop the ability to conceptually understand the atomic spectra of Hydrogen atoms and similar valence electron atoms.
- Be able to understand and interpret the atomic spectra for many electron atoms.
- Also, can explain the change in behavior of atoms in external applied electric and magnetic field and corresponding changes in observed spectra.
- Gain sufficient understanding of rotational, vibrational, electronic and Raman spectra of molecules.
- Develop skill in important material characterization techniques like IR/FTIR, Raman, etc.
- Acquire ability to apply Nuclear Magnetic Resonance (NMR) for structure elucidation of synthesized materials.
- The knowledge of various material characterization techniques will impart skills for direct employability.

Credits: 4	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40

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

Unit	Topics	No. of Lectures
I	**Atomic Physics -I:** Introduction to Atomic spectra, Quantum states of an electron in Hydrogen atom. Relativistic corrections for energy levels of hydrogen atom. Concept of spin and fine structure of hydrogen atom. Singlet and triplet States of Helium. Broad features of spectra of alkali elements. Fine structure in Alkali Spectra.	15
II	**Atomic Physics - II:** Many electron atoms: Central field approximation, atomic wave function, Hartree and Hartree–Fock approximations, Results of Hartree's theory, Spectroscopic Terms: LS coupling, Lande Interval rule, determination of spectral terms for atoms; with two or more Non-equivalent optical electrons, and two or more equivalent optical electrons. Breit's scheme. JJ coupling for many electron atoms. Atom in external field, Zeeman, Paschen-Bach & Stark effects.	15
III	**Molecular Physics:** Born-Oppenheimer approximation, Classification of Molecules, Types of Molecular Spectra and Molecular Energy States: Pure Rotational Spectra, Vibrational-Rotational Spectra, Raman Scattering, Classical and Quantum theory of Raman effect. Selection rules, Isotope effect, Formation of electronic spectra, fine structure of electronic bands. Intensity distribution in electronic bands: Franck-Condon principle. Explanation of intensity distribution in absorption and emission bands from Franck-Condon principle.	20

IV	**Characterization Techniques:** Infrared/FTIR Spectroscopy, General description and working of dispersive and FTIR instrument. Interpretation of FTIR spectra. Raman spectroscopy. Nuclear Magnetic Resonance, Chemical Shift, NMR Spectrometer. NMR spectrum analysis. Magnetic Resonance, Chemical Shift, NMR Spectrometer. NMR spectrum analysis.	10

Suggested Readings:

11. White, H.E., "Introduction to atomic spectra".
12. Herzberg, "Spectra of diatomic molecules".
13. Weissbluth, M., "Atoms and Molecules".
14. Slater, "Quantum theory of Atomic Structure, Vol. 1".
15. Slater, "Quantum theory of Molecules and Solids".
16. Banwell, C.B., "Fundamentals of Molecular Spectroscopy".
17. Barrow, G.M., "Introduction to Molecular Spectroscopy".
18. Brown, J.M., "Molecular Spectroscopy".
19. Larkin, Peter J., "Infrared and Raman Spectroscopy: Principles and Special Interpretation".
20. Ghatak, Ajoy & Thyagarajan, K., "Lasers: Fundamentals and Applications".

Suggestive digital platforms web links-

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

4. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation (CIE) of 25 marks shall be based on the class test, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: **Bachelor Degree (Honours with Research)**		Year: 4	Semester: 8
Subject: **PHYSICS**			
Course Code: **0820104**	Course Title: **NUCLEAR AND PARTICLE PHYSICS**		

Course outcomes:

5. Students will be more enlightened with the study of nuclear Physics and ready to go for further study.
6. This course will be useful to understand different aspects of nuclear physics.
7. This course will give a better insight which will be a good boost for the students.
8. General introduction of nucleus with modern technology may open the Broadway of nucleus.

Credits: **4**	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40

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

Unit	Topics	No. of Lectures
I	**General Introduction:** Scattering of α particles, Mirror nuclei, μ meson atoms consideration, Idea of protonic charged nuclear dimensions. Nuclear mass, Nuclear angular momentum and magnetic moment, electric quadrupole moment, Parity quantum number, Statistics of nuclear particles, Isobaric spin concept, Electron capture, Partial wave analysis of n-p scattering, phase shift, single and triplet potentials	15
II	**General β decay DISINTEGRATION:** Fermi theory of allowed β decay. Non conservation of parity and Wu's experiment, Internal conversion.	05
III	**Interaction and Detection of Nuclear Radiation with matter Chemical and Biological effects of radiation:** Interaction of charged particles with matter, Stopping power of heavy charged particles, Range and straggling of electrons. Introduction of Ionization chamber , Proportional counter ,G.M. counter ,scintillation counter . Radiation monitoring and Dosimeters, Physical effects of radiation, Chemical effects of radiation. Effects of radiation on water and aqueous solutions, Penetration and ionizing power of nuclear radiations in the human body.	18

IV	**Nuclear Models:** Single particle, Individual particle model, predictions of shell model and magic numbers.	05

V	**Nuclear elementary particles:** General idea of elementary particles, Conservation laws, CP and CPT invariance, introductions of hadrons, quarks, Gell-Mann Okubu mass formula, Formation of stars, Chandrashekhar limit, neutron rich matter and supernova explosion	07

Suggested Readings:

4. Srivastava, B.B., "Fundamentals of Nuclear Physics".

5. Ghoshal, S.N., "Nuclear Physics" S. Chand Publications.

6. Tayal, D.C., "Nuclear Physics" Himalaya Publications.

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5. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

6. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on the class test, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: **Bachelor Degree (Honours with Research)**		Year: 4	Semester: 8
Subject: **PHYSICS**			
Course Code: **0820180**	Course Title: **PHYSICS LAB II**		

Course Outcomes:

- At the end of the laboratory course, each and every student is expected to understand the basic concepts of electronics/nuclear physics through experiments.
- The students will get a better understanding of the concepts studied by them in the theory course and correlate with experimental observations.
- The student will gain practical knowledge of designing, assembling and testing electronics circuits as well as understanding troubleshooting.
- The student would be equipped with an in-depth knowledge of Physics that can be applied in higher studies in every field of Physics.

Credits: **4**	Core Compulsory / Elective: Core Compulsory
Max. Marks: 100	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-8	

List of Experiments-

Choose any **six** experiments from the given list.

1. To study the frequency response and to calculate the various parameters such as input Impedance, output impedance current gain and voltage gain of the emitter follower.
2. To study the Drain characteristics and Mutual characteristics of a N/P channel MOSFET
3. To study the characteristics of a junction field effect transistor and to calculate the various parameters as

   (a)drain dynamic resistance (b)mutual conductance (c) amplification factor

4. To study and compare the following transistor biasing techniques and calculate the Bias voltage and transistor currents in-

   a. Single battery biasing (b) Two battery biasing (c) Voltage divider bias (d) Collector to base bias

5. To study the forward and reverse bias characteristics of the following diodes-

   a. Germanium diode (b) Silicon diode (c) Zener diode (d) Light emitting diode

6. To study the characteristics of a P-N junction and determine –

   (c) Reverse saturation current (b) Material constant (c) Determination of temperature coefficient of the Junction (d) Junction voltage and energy band gap.

7. To study the diffraction pattern of a semiconductor laser and –

   (d) Determine the width of the single slit from the diffraction pattern.

   (e) Measure the thickness of the wire/obstacle.

(c) Determine the wavelength of the laser light using diffraction grating.

8. To study the absorption spectrum of iodine vapour and to obtain –

   (a) Energy level diagram for iodine molecule

   (b) Deducing the electronic excitation energy for iodine molecule

   (c) Deducing force constant for iodine molecule

9. To study the characteristics of a LED and –

   (a) Determination of Plank's constant (b) Determine the material constant

   (c) Determine the temperature coefficient

10. To study the characteristics of a Photocell and –

   (a) Determination of Plank's constant (b) Determine the material constant

   (c) Determine the temperature coefficient

11. To study a single stage R-C coupled amplifier cum feedback amplifier and draw its frequency response and measure –

   (a) Voltage/Power gain (b) Variation of gain (c) Input/Output Impedance

   (d) Phase relationship between input and output waveforms

12. To study a single stage L-C coupled amplifier cum feedback amplifier and draw its frequency response and measure –

   Voltage/Power gain (b) Variation of gain (c) Input/Output Impedance (d) Phase relationship between input and output waveforms

13. To study the dielectric constant and determine the Curie temperature of the ferroelectric ceramics.

14. To demonstrate the concept of quantization of energy levels in accordance with the Bohr model of atoms by Frank Hertz experiment.

15. To trace a B-H curve for a ferro-magnetic material using CRO and to find magnetic parameters from the B-H curve.

16. To calculate the resistivity of a semiconductor by Four-Probe method at different temperatures.

Suggested Evaluation Methods:

Evaluation of 100 marks shall be based on the experiments performed, viva-voce and lab records as per revised NEP guidelines (60+25+!5)

One experiment of four hour duration is to be performed