NATIONAL EDUCATION POLICY-2020

Syllabus for Sri Dev Suman Uttarakhand University, Badshahithaul, Tehri (Garhwal) and Affiliated Colleges

UG & PG PHYSICS SYLLABUS

2023

Sri Dev Suman Uttarakhand University Badshahithaul, Tehri (Garhwal)

Curriculum Design Committee, Uttarakhand

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

Syllabus Preparation Committee

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

S.N.	Name	Designation
1.	Dr. Yogesh Kumar Sharma	Professor & Head
2.	Dr. Manoj Yadav	Professor
3.	Dr. Bimal Prkash Bahuguna	Professor
4.	Dr. Hemant Singh	Associate Professor

B: Experts from Other Institutions

S. N.	Name	Designation and Address
1.	Prof. G. K. Dhingra	Dean. Faculty of Science, Pt. L.M.S. Campus Rishikesh
2.	Prof. L. P. Purohit	Professor, Department of Physics, Gurukula Kangri (Deemed to be) University Haridwar
3.	Prof. Pushpa Negi	Principal & Professor of Physics, Govt. P. G. College, New Tehri
4.	Prof. Pankaj Pant	Principal, Govt. P. G. College, Nagnath Pokhari
5.	Prof. Kuldeep Singh Negi	Principal, Govt. P. G. College, Khanpur
6.	Prof. Anita Rawat	Director, USERC, Dehradun

National Education Policy-2020

Syllabus for Sri Dev Suman Uttarakhand University and All Affiliated Colleges for B.Sc. in Physics.

2023

List of Papers in Six Semesters (B.Sc.Degree) Semester-wise Titles of the Papers in Physics					
Year	**Sem.**	**Course Code**	**Paper Title**	**Theory/ Practical**	**Credits**
Certificate Course in Basic Physics					
FIRST YEAR	Sem I	CPT1001	Mechanics	Theory	(04)
		CPP 1002	Mechanical Properties of Matter	Practical	(02)
	Sem II	CPT 1003	Electricity and Magnetism	Theory	(04)
		CPP 1004	Demonstrative Aspects of Electricity & Magnetism	Practical	(02)
Diploma in Applied Physics					
SECOND YEAR	Sem III	DPT 2001	Thermodynamics and Statistical Physics	Theory	(04)
		DPP 2002	Demonstrative Aspects of Thermal Properties & Statistical Physics	Practical	(02)
	Sem IV	DPT 2003	Optics	Theory	(04)
		DPP 2004	Demonstrative Aspects of Geometrical and Physical Optics	Practical	(02)
Bachelor of Science					
THIRD YEAR	Sem V	BPT3001	Solid State Physics	Theory	(04)
		BPP3002	Demonstrative Aspects of Solid State Physics	Practical	(02)
		BPT 3003	Basic Electronics	Theory	(04)
		BPP 3002	Demonstrative Aspects of Basic Electronics	Practical	(02)
	Sem VI	BPT 3003	Modern Physics & Elementary Quantum Mechanics	Theory	(04)
		BPP3004	Demonstrative Aspects of Modern Physics & Elementary Quantum Mechanics	Practical	(02)
		BPT 3005	Analog and Digital Electronics	Theory	(04)
		BPP 3006	Demonstrative Aspects of Analog & Digital Circuits	Practical	(02)

Subject prerequisites:

1. For SemesterI:12thpass with subjects Physics, Chemistry & Mathematics
2. For SemesterII: Passed Semester I with Physics
3. For SemesterIII: Passed Semester II with Certificate Course in Basic Physics
4. For SemesterIV: Passed Semester III
5. For SemesterV: Passed Semester IV with Diploma in Applied Physics
6. For SemesterVI: Passed SemesterV

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.

PO 1	1. Competence in the methods and techniques of calculations using Mechanics. 2. Students are expected to have hands-on experience to apply the theoretical knowledge to solve practical problems.
PO2	1. Students are expected to have deep understanding of electricity and magnetism. 2. Student should be able to make basic electrical circuits and handle electrical instruments.
PO 3	1. Competence in the concepts of Thermodynamics and Statistical Physics. 2. Students are expected to have hands on experience in Thermal and Statistical Physics Experiments.
PO 4	1 Knowledge of different concepts in Geometrical and Physical Optics. 2 Students are expected to have hands on experience of Experiments of Geometrical and Physical Optics.
PO 5	1. Knowledge of basic concepts of solid state physics with their applications. 2. Students are expected to have an insight in handling in solid state and basic electronic instruments.
PO 6	1. Comprehensive knowledge of modern physics, elementary quantum mechanics, Analog & Digital electronics and their Applications. 2. Learn the integrated approach to analog electronic circuitry and digital electronics for R&D.

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

After completing this certificate course, the student should have

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

.

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

After completing this diploma course, the student should have

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

Programme specific outcomes (PSOs): **UG III Year / Bachelor of Science**	
After completing this degree course, the student should have:	
PSO 1	*Knowledge of Mechanics and basic properties of matter. The course will empower him to apply his theoretical knowledge in various physical phenomena that occur in day to day life and he can use this scientific knowledge for the betterment of the society.*
PSO2	*Understanding of basic concepts related to Electricity and Magnetism .He should be proficienct in designing and handling different electrical circuits*
PSO3	Expertise in different aspects of Thermal and Statistical Physics which serves as a basis for many physical systems used in industrial applications and deals with the physics and technology of Engines and Refrigerators. *Proficient in the field of Optics which will increase his demand in research and industrial establishments engaged in activities involving optical instruments.*
PSO4	*Proficient in the field of Solid State Physics which will increase his demand in R & D.*
PSO5	*Basic knowledge in the field of Modern physics and Quantum Mechanics* which have utmost importance at both undergraduate and graduate level.
PSO6	Comprehensive knowledge of Basic Electronics, Analog & Digital Principles and their Applications. Learn the integrated approach to analog electronic circuitry and digital electronics for R&D.

	Year wise Structure of B.Sc. in Physics (CORE / ELECTIVE COURSES & PROJECTS)													
	Subject: Physics													
Type of Programme	**Year**	**Sem**	**Paper I**	**Credit /hrs**	**Paper 2**	**Credit/ hrs**	**Paper 3**	**Credits /hrs**	**Paper 4**	**Credits /hrs**	**Elective Paper**	**Credits /hrs**	**Research Project**	**Credit/hrs**
Certificate	I	I	**Mechanics (Theory)**	4/60	**Mechanical Properties of Matter (Lab)**	2/60					EL1 (One from the list) (04)	4/60		
		II	**Electricity and Magnetism (Theory)**	4/60	**Demonstrative Aspects of Electricity& Magnetism (Lab)**	2/60								
Diploma	II	III	**Thermodynamics and Statistical Physics (Theory)**	4/60	**Demonstrative Aspects of ThermalProperties of Matter and Statistical Physics (Lab)**	2/60					EL2 (One from the list) (06)	4/60		
		IV	**Optics(Theory)**	4/60	**Demonstrative Aspects of Geometrical and Physical Optics (Lab)**	2/60								
Bachelor of Science	III	V	**Solid State Physics(Theory)**	4/60	**Basic Electronics (Theory)**	4/60	**Demonstrative Aspects of Solid State Physics (Lab)**	2/60	**Demonstrative Aspects of Basic Electronics (Lab)**	2/60			Industrial Training/Research Project	Qualifying
		VI	**Modern Physics & Elementary Quantum Mechanics (Theory)**	4/60	**Analog and Digital Electronics (Theory)**	4/60	**Demonstrative Aspects of Modern Physics & Quantum Mechanics (Lab)**	2/60	**Demonstrative Aspects of Analog & Digital Circuits(Lab)**	2/60			Industrial Training/Research Project	Qualifying

CERTIFICATE COURSE IN BASIC PHYSICS

Programme: *Certificate Course in Basic Physics*	**Year: I**	**Semester: I Paper-I**

Subject: Physics

Course Code:	**Course Title: Mechanics**

Course Outcomes

1. Understanding of Vector Algebra and Vector Calculus.
2. Understand the physical interpretation of gradient, divergence and curl.
3. Study of gravitational field and potential and understanding of Kepler's laws of Planetary motion.
4. Understanding of different frames of references and conservation laws.
5. Understand the dynamics of rigid body and concept of moment of inertia. Study of moment of inertia of different bodies and its applications.
6. Study the properties of matter, response of the classical systems to external forces and their elasticdeformation and its applications.
7. Comprehend the dynamics of Fluid and concept of viscosity and surface tension along with its applications.

Credits: 04	**Core Compulsory**
Max. Marks: 100 **External Exam: 75** **Internal Assessment : 25**	**Min. Passing Marks: 33**

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

Unit	**Topic**	**No. of Lectures**
Unit I	**Vectors Algebra** Vector algebra. Scalar and vector products, scalar and vector triple products, Derivative of a vector with respect to a parameter, Del operator, gradient, divergence and curl, Gauss divergence theorem, Stokes curl theorem and Green's theorem, Line, surface and volume integral of a vector function.	**10**
Unit II	**Gravitation field and potential** Gravitational field and potential, Gravitational potential energy, Gravitational field Intensity and potential due to a ring, a spherical shell, solid sphere and circular disc, gravitational self-energy, Inverse square law of forces, Kepler's laws of planetary motion.	**10**

Unit III	**Conservation Laws** Frames of reference, Concept of inertial and Non-inertial frames of references, Work energy theorem, Conservative and non-Conservative forces, Linear restoring force, Gradient of potential, Conservation of energy for the particle, Energy function, Concept of Centre of mass, Angular momentum and torque, Laws of conservation of total energy, total linear momentum and total angular momentum along with their examples.	**15**
Unit IV	**Dynamics of rigid body and Moment of Inertia** Translatory and Rotatory motion, Equation of motion for Rotating rigid body, angular momentum vector and moment of inertia, Theorem of parallel and perpendicular axes, Moment of inertia of a cylinder, rod, lamina, ring, disc, spherical shell, solid sphere, kinetic energy of rotation, rolling along a slope, Application to compound pendulum.	**10**
Unit V	**Properties of Matter** Basic concept, Elastic constants and their Interrelations, torsion of cylinder, bending of beam, bending moment, Cantilever, shape of Girders/ rail tracks. Viscosity, Stokes's law, Posieuille's formula, Equation of continuity, Bernoulli's theorem, Surface tension and its molecular interpretation.	**15**

Suggested Reading

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

Suggested Online Link:

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

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

Suggested Continuous Evaluation (25 Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

Course Prerequisites: Physics and Mathematics in 12^{th}

CERTIFICATE COURSE IN BASIC PHYSICS

Programme: *Certificate Course in Basic Physics*	**Year: I**	**Semester: I Practical (Lab)**

Subject: Physics Practical (Lab)

Course Code	**Course Title:** Mechanical Properties of Matter (Lab)

Course Outcomes:

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

Credits: 02	**Core Compulsory**
Max. Marks: 50 **Internal (Record File): 15** **External Practical Exam: 20** **External Viva Voce : 15**	**Min. Passing Marks: 17**

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

Unit	**Topic**	**No. of Lectures**
	Lab Experiment List	
	1. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity. 2. To determine the Moment of Inertia of a Flywheel. 3. To determine g and velocity for a freely falling body using Digital Timing Technique. 4. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method). 5. To determine the Young's Modulus of a Wire by Optical Lever Method. 6. To determine the Young's Modulus by bending of beam. 7. To determine the Modulus of Rigidity of a Wire by Maxwell's needle. To determine the elastic Constants of a wire by Searle's method. 8. To determine the value of g using Bar Pendulum. 9. To determine the value of g using Kater's Pendulum. 10. To determine Surface Tension. 11. To determine the modulus of rigidity by Barton's Appratus (Horizontal and Vertical) 12. To determine the elastic constants by Searle's method	**60**

Suggested Readings:

1. M. Yadav, Practical Physics, Vol 1, KedarNath Ramnath Publication, 2023.
2. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962.
3. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015.
4. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014.

Suggestive Digital Platforms / Web Links:

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

Suggested Continuous Evaluation Methods:

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

Record File (15 marks)

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

Further Suggestions:

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

CERTIFICATE COURSE IN BASIC PHYSICS			
Programme:*Certificate Course in Basic Physics*		**Year:I**	**Semester:I Vocational/ Minor**
Subject:Physics			
Course Code:	**CourseTitle: Basic Instrumentation Skills-I**		
Credits:03		**Vocational/Minor (Experiments/hands on training)**	
Max. Marks:100 **External Exam:75** **Internal Assessment:25**		**Min.PassingMarks:33**	
Total No. of Lectures-Tutorials-Practical (in hours per week):3-0-0			

Unit	Topic	No. of Lectures
UnitI	**Errors and Mechanical Tools:** Instruments accuracy, precision, sensitivity, resolution, range, least count of different instruments, Errors in measurements, Types of errors. Hand tools and their Uses: Identification, specifications, uses and maintenance of commonly used hand tools: Tweezers Screwdriver (Combination Set), Pliers, Wire Cutters, Wire Strippers, Crimping Tools, Sockets & Hex drivers, Clamps, Rotary Tools: Grinders, Portable Drill Machine, Small Hand Saws.	**15**
UnitII	**Electrical & Electronics Cables and Connector** Different type of electrical cables and their Specifications. Types of wires & cables, Standard wire gauge (SWG), Practice on different type of cable joint, Testing phase , neutral and Earth by tester and multi-meter and test lamp.	**10**
UnitIII	**Domestic Wiring** Introduction and explanation of electrical wiring systems, cleat wiring, casino & Capping, house wiring, specification and types, rating & material, Demonstration & Practice on connecting common electrical accessories in circuits and testing them in series board., Testing & replacement of differen1 types of fuses, switches, plug, sockets. Identification of different wiring materials and their specification, Removing of insulation from assorted wires and cable, Making a switch board with electrical accessories, Making Extension board.	**20**

Suggested Reading

1. B L Theraja: A text book in Electrical Technology
2. S. Sa1ivahanan& N. S. Kumar: Electronic Devices and Circuits 3rd Edn
3. Shashi Bhushan Sinha, Handbook of Repair and Maintenance of Domestic Electronics Appliances hand book.
4. M. Lotia, Modem Basic Electrical & House Wiring Servicing

Suggested OnlineLink:

1. MITOpenLearning-MassachusettsInstituteofTechnology,https://openlearning.mit.edu/
2. NationalProgrammeonTechnologyEnhancedLearning(NPTEL),https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel,https:// www.swayamprabha.gov.in/index.php/program/current_he/8

Suggested Continuous Evaluation (25Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

CERTIFICATE COURSE IN BASIC PHYSICS

Programme: *Certificate Course in Basic Physics*	**Year: I**	**Semester: II Paper-I**

Subject: Physics

Course Code:	**Course Title: Electricity and Magnetism**

Course Outcomes:

1. Understanding of Electric Field and Potential. Evaluation of Electric Field and Potential for different types of charge distributions.

2. Study of Electric and Magnetic Fields in matter. Understand the concept of polarizability, Magnetization and Electric Displacement Vector.

3. Study of Steady and Varying electric currents.

4. Understanding of different aspects of alternating currents and its applications.

5. Understand the Magnetostatics, Lorentz Force and Energy stored in magnetic Field.

6. Comprehend the different aspects of Electromagnetic induction and its applications.

Credits: 04	**Core Compulsory**
Max. Marks: 100 **External Exam: 75** **Internal Assessment : 25**	**Min. Passing Marks: 33**

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

Unit	**Topic**	**No. of Lectures**
Unit I	**Electric field and potential** Coulomb law, Gauss' theory, its integral and differential forms, line integral of Electric field, Electric field and potential due to an arbitrary charge distribution. Electrostatic energy, energy stored in an Electric field. Electric field and potential due to long charged wire, Spherical shell, sphere, disc, dipole.	**15**
Unit II	**Electric and Magnetic fields in Matter** Moments of charge distributions, Polar and non-polar molecule, polarization vector, electric displacement vector, three electric vectors, dielectric susceptibility and permittivity, polarizability, Clausius-Mossotti relation Magnetization, magnetic susceptibility, diamagnetic, paramagnetic and ferromagnetic substances, Hysteresis and B-H curve, Langevin's theories of Diamagnetism and paramagnetism, Weiss theory of ferromagnetism.	**15**
Unit III	**Electric Currents (Steady and Varying)** Current density, Equation of Continuity, Ohm's law and electrical conductivity, Lorentz Drude theory, Wiedmann-Frenz law, Kirchhoff's Laws and their applications, Transient current, Growth and decay of D. C. in L - R and L - C circuits, charging and discharging of a capacitor through a resistance	**10**

Unit IV	**Magnetostatics** Lorentz force, Bio-Savert's law, Ampere's law, Application of Biot-Saver law, magnetic field due steady current in a long straight wire, Interactio between two wires, field due a Helmholtz coil, solenoid and current loop, magnetic vector potential, permeability, Energy stored in Magnetic field.	**10**
Unit V	**Electromagnetic Induction and Alternating Current** Faraday's laws of induction, Lenz's law, Electromotive force, Measurement o magnetic field, Eddy current, Mutual inductance, Self-inductance. Impedance admittance and reactance, R-C, R-L and L-C circuits with alternating e.m.f. source, series and parallel L-C-R circuits, resonance and sharpness, Quality factor, Power in A. C. circuits, Choke coil.	**10**

Suggested Reading

1. Edward M. Purcell : Electricity and Magnetism

2. J.H. Fewkes & J.Yarwood : Electricity & Magnetism, Vol. I

3. D C Tayal : Electricity and Magnetism ", Himalaya Publishing House Pvt. Ltd., 2019.

4. D.J.Griffiths : Introduction to Electrodynamics .

5. Lal and Ahmed : Electricity and Magnetism

6. H. K. Malik and A.K. Singh "Engineering Physics", McGraw Hill Education (India) Private Limited, 2018.

7. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics Vol. 2", Pearson Education Limited, 2012.

Suggested Online Link:

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

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

Suggested Continuous Evaluation (25 Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

Course Prerequisites: Passed semester I, theory paper-1

CERTIFICATE COURSE IN BASIC PHYSICS

Programme: *Certificate Course in Basic Physics*	**Year: I**	**Semester: II Practical (Lab)**

Subject: Physics Practical (Lab)

Course Code:	**Course Title:** Demonstrative Aspects of Electricity & Magnetism (Practical)

Course Outcomes:

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

Credits: 02	**Core Compulsory**
Max. Marks: 50 **Internal (Record File): 15** **External Practical Exam: 20** **External Viva Voce : 15**	**Min. Passing Marks: 17**

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

Unit	**Topic**	**No. of Lectures**
	Lab Experiment List	
	1. Frequency of A.C. Mains. 2. Calibration of Voltmeter by potentiometer. 3. Calibration of ammeter by potentiometer. 4. Specific resistance determination. 5. Conversion of a Galvanometer into a Voltmeter. 6. Conversion of a Galvanometer into Ammeter. 7. Variation of magnetic field along the axis of a current carrying circular coil. 8. Comparison of capacities by Ballistic Galvanometer. 9. Determination of Ballistic Constant. 10. Electrochemical equivalent. 11. De Sauty's bridge- C1/ C2 12. R1/R2 by potentiometer. 13. Study of R-C, L-C-R circuits. 14. Determination of self inductance, mutual inductance. 15. Magnetic field determination by search coil and ballistic galvanometer.	**60**

Suggested Readings:

1. M. Yadav, Practical Physics, Vol 1, KedarNath Ramnath Publication, 2023.
2. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962.
3. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015.
4. S.L. Gupta, V. Kumar, "Practical Physics", PragatiPrakashan, Meerut, 2014.

Suggestive Digital Platforms / Web Links:

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

Suggested Continuous Evaluation Methods:

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

Record File (15 marks)

PREREQUISITE: Passed Semester I

Further Suggestions:

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

CERTIFICATECOURSEINBASICPHYSICS		
Programme:*Certificate Course in Basic Physics*	**Year: I**	**Semester: II Vocational/Minor**
Subject:Physics		
Course Code:	**CourseTitle: Basic Instrumentation Skills -II**	
Credits:03	Vocational **(Experiments/hands on training)**	
Max.Marks:100 **ExternalExam:75** **InternalAssessment:25**	**Min.PassingMarks:33**	
TotalNo.ofLectures-Tutorials-Practical (inhoursperweek):3-0-0		

Unit	Topic	No. of Lectures
UnitI	**Batteries and Maintenance:** Types of Batteries, Primary Cell, Secondary Cell, Wet charged, Dry-charged, Low maintenance, Construction of Battery, Case Cover plates, Separator, Cells, Electrolyte, Principles of Batteries, Lead Acid battery, Electrochemical reaction, Measure the voltages of the given cells/battery using analog/ digital multimeter, Charge and discharge the battery through load resistor, Maintain the secondary cells, Measure the specific gravity of the electrolyte using hydrometer.	**20**
UnitII	**Testing of Batteries:** Testing Factor affecting charging, Cause of battery failure, diagnosis and testing, visual inspection, Heavy load test Professional, Test a battery and verify whether the battery is ready for use of needs recharging.	**10**
UnitIII	**Soldering**: Solders, flux and soldering technique. Different types of soldering guns related to Temperature and wattages, types of tips, Solder materials and their grading. Use of flux and other materials, Selection of soldering gun for specific requirement, Soldering and De-soldering stations and their specifications. Soldering/ De-soldering and Various Switches, Practice soldering on differeni electronic components, small transformer, Practice de-soldering	**15**

SuggestedReading

1. B L Theraja: A text book in Electrical Technology
2. M G Say: Performance and design of AC machines
3. S. Salivahanan& N. S. Kumar: Electronic Devices and Circuits, , 3rd Edn
4. Shashi Bhushan Sinha, Handbook of Repair and Maintenance of Domestic Electronics Appliances hand book.
5. M. Lotia, Modern Basic Electrical & House Wiring Servicing

Suggested OnlineLink:

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

Suggested Continuous Evaluation (25Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

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

Students having major in Physics will have to choose the elective/minor from sl. no. 1-4 only. Other faculty students (Arts/Commerce) have to choice sl. no. 1.

1. Elementary Physics-I
2. Numerical Methods
3. Computer Programming
4. Waves and Oscillations

CERTIFICATE COURSE IN BASIC PHYSICS		
Programme: ***Certificate Course in Basic Physics***	**Year: I**	**Semester: I/II**
Subject: Physics		
CourseCode:	**CourseTitle: Elementary Physics-I**	
Credits:04	**Vocational/Minor(Experiments/hands on training)**	
Max.Marks:100 **External Exam:75** **Internal Assessment:25**	**Min.PassingMarks:33**	
Total No.of Lectures-Tutorials-Practical (in hours per week):4-0-0		

Unit	Topic	No. of Lectures
Unit I	Basic Idea of Physics and it's uses in daily life, Electric charge, Conductors, Insulators and Semiconductors, Coulomb's law, Quantization and conservation of charge, Basic Idea of electric field	**15**
Unit II	Resistance, Resistance in Series and Parallel, Direct and Alternating Current, Color codes for Resistors, Household Circuits, Wiring in Houses, Importance of fuse, Power and Power Losses, Unit of power loss, Heating effect of electric current, Uses of heating effect of current.	**15**
Unit III	Transformers, Types of transformers, Step up transformer, Step down transformer, Auto transformer, Central tape transformer, Wiring of transformer.	**10**
Unit IV	Short and open circuits, Shorts in series circuit, shorts in parallel circuit, Open in series circuit, Open in parallel circuit, Duality in series and parallel circuits.	**10**

Unit V	Ammeters- Voltmeters and their uses, Measurements of thickness, Diameter and depth by Vernier- calipers Screw gauge and Spherometer, Multimeter and its uses, Dynamometer and Wattmeter, Block diagram of basic CRO, Construction of CRT, Electron gun, electrostatic focusing and acceleration.	**10**

Suggested Reading:

1. Physics: Rowell and Herbert, Cambridge University Press,

2. Electrical Technology : B. L. Theraja, S. Chand & company.

Suggested Online Link:

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

Suggested Continuous Evaluation (25 Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

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

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

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

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

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

Suggested Reading

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

Suggested Online Link:

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

Suggested Continuous Evaluation (25 Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

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

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

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

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

Suggested Reading

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

Suggested Online Link:

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

Suggested Continuous Evaluation (25 Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

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

Credits: 04	**Minor/Elective**
Max. Marks: 100 **External Exam: 75** **Internal Assessment: 25**	**Min. Passing Marks: 33**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0	

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

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

Suggested Reading

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

Suggested Online Link:

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

Suggested Continuous Evaluation (25 Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

DIPLOMA IN APPLIED PHYSICS

Programme: *Diploma in Applied Physics*	**Year: II**	**Semester: III Paper-I**

Subject: Physics

Course Code:	**Course Title: Thermodynamics and Statistical Physics**

Course Outcomes:

1. Recognize the difference between reversible and irreversible processes.
2. Understand First and Second Law of Thermodynamics and concept of Entropy.
3. Understand the physical significance of thermo dynamical potentials.
4. Comprehend the kinetic model of gases w.r.t. various gas laws.
5. Study the implementations and limitations of fundamental radiation laws.

Credits: 04	**Core Compulsory**
Max. Marks: 100 **External Exam: 75** **Internal Assessment: 25**	**Min. Passing Marks: 33**

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

Unit	**Topic**	**No. of Lectures-60**
Unit I	**Basic concepts and First law of thermodynamics** Thermodynamic Systems, Thermal equilibrium and Zeroth law of thermodynamics, Equation of state and First law of thermodynamics, Discussion of Heat and Work, Quasi-static Work; Reversible and Irreversible; Path Dependence; Heat Capacities Adiabatic Processes, Vander Wall equation, Distinction between Joule, Joule- Thompson and Adiabatic expansion of a gas.	**10**
Unit II	**Second law of Thermodynamics and Entropy** Insufficiency of first law of thermodynamics, Condition of Reversibility, Carnot‟s Engine and Carnot‟s Cycle, Second law of thermodynamics, Carnot‟s Theorem, Thermodynamic scale of temperature and its identity to perfect gas, scale of temperature. Entropy, Mathematical formulation of Second law of thermodynamics, Entropy of an ideal gas, T-S diagram and its applications, Evaluation of Entropy changes in simple cases, Third law of thermodynamics.	**10**
Unit III	**Thermodynamic Relations** Thermodynamic potentials, Maxwell‟s equation from thermodynamic potentials, Some useful manipulations with partial derivatives (cooling in adiabatic processes and Adiabatic stretching of a wire), The Clausius–Clapeyron‟s equations, Triple point, Applications of Maxwell‟sthermo	**10**

	dynamical relations.	
Unit IV	**Transport of Heat and Kinetic theory of Gases** Black body radiation, Thermodynamics of radiations inside a hollow enclosure, Kirchoff‟s Laws, Derivation of Stefan Boltzmann Law, Wein‟s displacement law, Black body spectrum formulaearly attempts, Raleigh Jean‟s Law, Quantum theory of Radiation, Planck‟s formula for black body spectrum, Wien‟s law, Radiation as a photon gas. Degree of Freedom Law of Equipartition of Energy, Distributive law of velocities, Most Probable speed, Average and root mean square velocities.	**15**
Unit V	**Fundamentals of Statistical Mechanics:** Probability and thermodynamic probability, postulates of statistical mechanics, macrostates and microstates, equilibrium and fluctuation constraints, ensemble and average properties, phase space, μ-space and gamma space, division of phase space into cells, Micro canonical, canonical and grand canonical ensembles, Entropy and probability, interpretation of second law of thermodynamics, Boltzmann canonical distribution law. Classical and Quantum statistics, Comparison of three statistics.	**15**

Suggested Reading

1. S. Loknathan : Thermodynamics, Heat and Statistical Physics
2. Sharma and K.K. Sarkar : Thermodynamics, and Statistical Physics
3. Brijlal and Subrahmanyam : Heat and Thermodynamics
4. Garg, Bansal and Ghose: Thermal Physics, McGraw Hill,2012.
5. M.W. Zemansky, R. Dittman, “Heat and Thermodynamics”, McGraw Hill,1997.
6. R. K Pathria, Statistical Mechanics, Elsevier
7. Meghnad Saha, B.N. Srivastava, “A Treatise on Heat”, Indian Press,1973

Suggested Online Link:

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

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

Suggested Continuous Evaluation (25 Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

Course Prerequisites: Passed Certificate course in Basic Physics.

DIPLOMA IN APPLIED PHYSICS		
Programme: ***Diploma in Applied Physics***	**Year: II**	**Semester: III Practical (Lab)**
Subject: Physics Practical (Lab)		
Course Code:	**Course Title:** Demonstrative Aspects of Thermodynamics and Statistical Physics (Practical)	

Course Outcomes:

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

Credits: 02	**Core Compulsory**
Max. Marks: 50 **Internal (Record File): 15** **External Practical Exam: 20** **External Viva Voce : 15**	**Min. Passing Marks:17**

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

Unit	Topic	No. of Lectures
	Lab Experiment List	
	1. Thermal conductivity of a bad conductor by Lee's method. 2. Mechanical equivalent of heat by Searle's method. 3. Stefan's law 4. Platinum resistance thermometer. 5. Thermal conductivity of a good conductor by Searle's method. 6. J by Callendar and Barnes method. 7. Random throw- statistical method. 8. Newton's law of cooling, sp. heat of Kerosene oil. 9. Variation of thermos emf across two junctions of a thermocouple with temperature 10. To show that deviation of probability of an event from theoretical values decreases with increase in the number of events (throuch coins and dices) 11. To verify the laws of probability distribution and to verify laws of probability of throwing one coin, two coin and ten coins 12. Study of statistical distribution from the given data and to find most probable value, averge value and rms value	**60**

Suggested Readings:

1. M. Yadav, Practical Physics, Vol 2, KedarNath Ramnath Pubaws of lication, 2023.
2. B.L. Worsnop, H.T. Flint, “Advanced Practical Physics for Students”, Methuen & Co., Ltd., London, 1962.
3. S. Panigrahi, B. Mallick, “Engineering Practical Physics”, Cengage Learning India Pvt. Ltd., 2015.
4. Indu Prakash: Practical Physics
5. S.L. Gupta, V. Kumar, “Practical Physics”, Pragati Prakashan, Meerut, 2014.

Suggestive Digital Platforms / Web Links:

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

Suggested Continuous Evaluation Methods:

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

Record File (15 marks)

PREREQUISITE: Passed Certificate course in Basic Physics

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.

DIPLOMAINAPPLIEDPHYSICS			
Programme:*Diploma in Applied Physics*		**Year:II**	**Semester: III Vocational/Minor**
Subject:Physics			
CourseCode:	**CourseTitle: Basic Instrumentation Skills -III**		
Credits:03		**Vocational/Minor**	
Max.Marks:100 **ExternalExam:75** **InternalAssessment:25**		**Min.PassingMarks:33**	
Total No.ofLectures-Tutorials-Practical (in hours per week):3-0-0			

Unit	Topic	No.of Lectures
UnitI	**Multimeter** Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance Advantage over conventional multimeter for voltage measurement with respeci to input impedance and sensitivity.	**20**
UnitII	**Digital Multimeter** Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/frequency counter, time-base stability, accuracy and resolution.	**10**
UnitIII	**Electronic Voltmeter** Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter, AC millivoltmeter: Type of AC millivoltmeters, Block diagram ac milli -voltmeter, specifications and their significance.	**15**

Suggested Reading

Books Recommended:

1. B L Theraja : A text book in Electrical Technology
2. M G Say : Performance and design of AC machines
3. S. Sa1ivahanan& N. S.Kumar: Electronic Devices and Circuits, , 3rd Edn
4. Shashi Bhushan Sinha, Handbook of Repair and Maintenance of Domestic Electronics Appliances hand book.

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

Suggested Continuous Evaluation (25Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

Course Prerequisites: Passed Certificate course in Basic Physics and Passed Semester III.

DIPLOMA IN APPLIED PHYSICS

Programme: *Diploma in Applied Physics*	**Year: II**	**Semester: IV Paper-I**

Subject: Physics

Course Code:	**Course Title: Optics**

Course Outcomes:

1. Study of Fermat's Principle of Extremum Path and understand fundamental physics behind reflection and refraction of light.
2. Understand the theory of image formation by an optical system.
3. Study of different types of optical Aberration sand techniques for the irreduction.
4. Study of different types of optical instruments used in industry and research.

Credits:04	**Core Compulsory**
Max.Marks:100 **External Exam:75** **Internal Assessment:25**	**Min.Passing Marks:33**

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

Unit	Topic	No. of Lectures
Unit I	**Geometrical Optics:** Fermat's Principle: Principle of extremum path and its application to deduce laws of reflection and refraction, Gauss's general theory of image formation: Coaxial symmetrical system, Cardinal points of an optical system, general relationship, thick lens and lens combinations.	**10**
Unit II	**Optical Instruments:** Entrance and exit pupils, need for a multiple lens eyepiece, Ramsden's, Huygen's and Gaussian eyepieces, Astronomical refracting telescope, Spectrometer, Aberrations in images: Chromatic aberrations, achromatic combination of lenses in contact and separated lenses, Monochromatic aberrations and their reduction: aspherical mirrors and Schmidt corrector plates, aplantic points, oil immersion objectives meniscus lens.	**15**
Unit III	**Interference of Light:** The principle of superposition, Two slit interference, coherence, Division of wave front and amplitude, Optical path retardations lateral shift of fringes, Fresnel biprism, Interference with multiple reflection, Thin films, Application for precision measurements, Haidinger fringes, Fringes of equal thickness and equal inclination.	**15**
Unit IV	**Diffraction of Light:** Fresnel Diffraction: Half-period zones, Zone plate, Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis. Fraunhofer diffraction: Diffraction of a Single slit; Double Slit, Multiple slits and Diffraction grating.	**10**
Unit V	**Polarization of Light:** Transverse nature of light waves, Concept of Plane polarized light – production and analysis, Malus law, Brewster's law, Nicol prism, Circular and elliptical polarization, Double refraction.	**10**

Suggested Reading

1. Fundamentals of Optics, F A Jenkins and H E White, 1976, McGraw-Hill
2. Principles of Optics, B. K. Mathur, 1995, Gopal Printing
3. Fundamentals of Optics, H. R. Gulati and D.R. Khanna, 1991, R. Chand Publication
4. A Textbook of Optics, N. Subramanyam and Brijlal.
5. Optics and Atomic Physics, D. P. Khandelwal.
6. Physical Optics, A. K. Ghatak.
7. Optics, Eugene Hecht, Pearson Publishers.
8. Optics, Satya Prakash.

Suggested OnlineLink:

1. MIT Open Learning Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. Swayam Prabha - DTH Channel,

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

Suggested equivalent online courses:

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

Suggested Continuous Evaluation (25Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

Course Prerequisites: Passed Certificate course in Basic Physics and Passed Semester III.

DIPLOMA IN APPLIED PHYSICS			
Programme: ***Diploma in Applied Physics***		**Year: II**	**Semester: IV Practical (Lab)**
Subject: Physics Practical (Lab)			
CourseCode:	**Course Title:** Demonstrative Aspects of Optics(Practical)		
Course Outcomes: **1.** Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the optical properties. **2.** Measurement precision and perfection is achieved through Lab Experiments.			
Credits: 02		**Core Compulsory**	
Max. Marks: 50 **Internal (Record File): 15** **External Practical Exam: 20** **External Viva Voce : 15**		**Min. Passing Marks:17**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-4			
Unit	**Topic**		**No. of Lectures**
Lab Experiment List			
	1. Nodal slide assembly, Location of cardinal points of lens system. 2. Newton's formula. 3. Dispersive power of prism. 4. Resolving power of a telescope. 5. To determine the Resolving Power of a Prism. 6. To verify the Cauchy's dispersion formula. 7. To find the thickness of the wire using optical bench. 8. To determine the thickness of mica-sheet by using Biprism 9. Newtons ring experiment 10. To determine specific rotation of cane sugar using polarimeter 11. Diffraction grating 12. Malus Law 13. Sextant		**60**

Suggested Readings:

1. M. Yadav, Practical Physics, Vol 2, KedarNath Ramnath Publication, 2023.
2. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962.

3. S. Panigrahi, B. Mallick, “Engineering Practical Physics”, Cengage Learning India Pvt. Ltd., 2015.
4. Indu Prakash, Practical Physics
5. S.L. Gupta, V. Kumar, “Practical Physics”, PragatiPrakashan, Meerut, 2014.

Suggestive Digital Platforms / Web Links:

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

Suggested Continuous Evaluation Methods:

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

Record File (15 marks)

PREREQUISITE: Passed Certificate course in Basic Physics and Semester III.

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.

DIPLOMAINAPPLIEDPHYSICS		
Programme: *Diploma in Applied Physics*	**Year:II**	**Semester: IV Vocational/Minor**
Subject:Physics		
CourseCode:	**CourseTitle: Basic Instrumentation Skills -IV**	
Credits:03	**Vocational (Experiments/hands on training)**	
Max.Marks:100 **External Exam:75** **Internal Assessment:25**	**Min. Passing Marks:33**	
TotalNo.ofLectures-Tutorials-Practical (in hours per week):3-0-0		

Unit	Topic	No. of Lectures
UnitI	**Cathode Ray Oscilloscope**: Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only— no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance. Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.	**20**
UnitII	**Signal and pulse Generators** Block diagram, explanation and specifications of low frequency signal generator and pulse generator. Brief idea for testing, specifications. Distortion factor meter,wave analysis.	**10**
UnitIII	**Impedance Bridges** Block diagram of bridge. Working principles of basic (balancing) RLC bridge, Specifications of RLC bridge, Block diagram and working principle as of a Q-meter, Digital LCR bridges.	**15**

Suggested Reading

Books Recommended:

1. B L Theraja: A text book in Electrical Technology
2. M G Say: Performance and design of AC machines
3. S. Sa1ivahanan& N. S. Kumar: Electronic Devices and Circuits, 3rd Edn
4. Shashi Bhushan Sinha, Handbook of Repair and Maintenance of Domestic Electronics Appliances hand book.

Suggested OnlineLink:

1. MITOpenLearning-MassachusettsInstituteofTechnology,https://openlearning.mit.edu/
2. NationalProgrammeonTechnologyEnhancedLearning(NPTEL),https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH

Minor/Elective (04 Credit, One from the list El2)

Students having major in Physics will have to choose the elective/minor from sl. no. 1-6. Other faculty students (Arts/Commerce) have to choice sl. no. 1.

1. **Elementary Physics-II**
2. **Elements of Modern Physics**
3. **Electromagnetic Theory**
4. **Optoelectronic Devices**
5. **Opto-Electronics and Laser Instrumentation**
6. **Classical Dynamics**

DIPLOMA IN APPLIED PHYSICS		
Programme: ***Diploma in Applied Physics***	**Year: II**	**Semester: III/IV**
Subject: Physics		
Course Code:	**Course Title: Elementary Physics-II**	

Credits: 04	**Minor/Elective**
Max. Marks: 100 **External Exam: 75** **Internal Assessment: 25**	**Min. Passing Marks: 33**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0	

Unit	**Topic**	**No. of Lectures**
Unit I	Semiconductors- P- type, n-type, Semiconductor materials, pn diode, Depletion region, Working of pn diode, characteristics, Diode as a rectifier, Transistors PNP and NPN and their working.	**15**
Unit II	OPTICS- Mirrors and lenses, image formation, lens formula, Ramsden and Huygens eyepieces.	**10**
Unit III	Newton's first and Second Law, Concept of force and mass, Some particular forces, Newton's third law, Friction, Properties of friction.	**10**
Unit IV	Rectilinear motion, laws of motion, Work and energy, conservation of energy, law of gravitation and Kepler's law (not derivation).	**10**
Unit V	Thermodynamics systems, Thermal equilibrium, Zeroth law, work done, first law of thermodynamics, Internal energy, enthalpy.	**15**

Suggested Reading:

1- Physics: Resnick and Halliday, John Wiley, New York.
2- Mechanics: D S Mathur, S Chand & company.
3- Semiconductor materials and devices, M S Tyagi, John Wiley, New York.
4- Basic Electronics: B L Theraja, S Chand & company.

Suggested Online Link:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL),

https://www.youtube.com/user/nptelhrd

3. Swayam Prabha - DTH Channel,

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

Suggested Continuous Evaluation (25 Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

DIPLOMA IN APPLIED PHYSICS		
Programme: ***Diploma in Applied Physics***	**Year: II**	**Semester: III/IV**
Subject: Physics		
Course Code:	**Course Title: Elements of Modern Physics**	

Credits: 04	**Minor/Elective**
Max. Marks: 100 **External Exam: 75** **Internal Assessment: 25**	**Min. Passing Marks: 33**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0	

Unit	Topic	No. of Lectures
Unit I	**Quantum Mechanics and Bohr Atom Model** Planck's quantum, Planck's constant and light as a collection of photons; Photoelectric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Rutherford model, Bohr's model, quantization rule and atomic stability; calculation of energy levels for hydrogen like atoms and their spectra.	**15**
Unit II	**Quantum Systems and Heisenberg Uncertainty Principle** Position measurement; Wave-particle duality, Heisenberg uncertainty principle- impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle.	**15**
Unit III	**Matter Waves and Schrödinger Equation** Two slit interference experiment with photons, atoms & particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wavefunction, probabilities and normalization; Probability and probability current densities in one dimension.	**15**
Unit IV	**Motion in a Potential Well** One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example; Quantum mechanical tunnelling in one dimension - across a step potential and across a rectangular potential barrier.	**15**

Suggested Reading:

1. Arthur Beiser: Concepts of Modern Physics
2. J. R. Taylor, C.D. Zafiratos: Modern Physics
3. Thomas A. Moore: Six Ideas that Shaped Physics: Particle Behave like Waves
4. Berkeley Physics Course: Vol.4 (Quantum Physics)
5. Serway, Moses, and Moyer: Modern Physics
6. G. Kaur and G.R. Pickrell: Modern Physics
7. B.L. Flint and H.T. Worsnop: Advanced Practical Physics for Students
8. Michael Nelson and Jon M. Ogbor: Advanced level Physics Practicals, , 4th Edition

Suggested Online Link:

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

Suggested Continuous Evaluation (25 Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

DIPLOMA IN APPLIED PHYSICS		
Programme: ***Diploma in Applied Physics***	**Year: II**	**Semester: III/IV**
Subject: Physics		
Course Code:	**Course Title: Electromagnetic Theory**	

Credits: 04	**Minor/Elective**
Max. Marks: 100 **External Exam: 75** **Internal Assessment: 25**	**Min. Passing Marks: 25**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0	

Unit	Topic	No. of Lectures
Unit I	**Maxwell's Equations** Review of electrostatic and electromagnetic equations, their differential and integral forms, Maxwell's equations. Displacement Current. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density.	**15**
Unit II	**EM Wave Propagation in Unbounded Media** Plane EM waves through vacuum and isotropic dielectric medium transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth.	**15**
Unit III	**EM Wave in Bounded Media** Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection and Refraction, Fresnel's Formulae, Brewster's law. Total internal reflection,	**15**
Unit IV	**Polarization of Electromagnetic Waves** Description of Linear, Circular and Elliptical Polarization. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices.	**15**

Suggested Reading

1. D.J. Griffiths: Introduction to Electrodynamics
2. M.N.O. Sadiku: Elements of Electromagnetics
3. T.L. Chow: Introduction to Electromagnetic Theory
4. M.A.W. Miah: Fundamentals of Electromagnetics

5. R.S. Kshetrimayun: Electromagnetic field Theory

6. Willian H. Hayt: Engineering Electromagnetic

7. J.A. Edminster: Electromagnetics, Schaum Series, 2006

8. B.L. Flint and H.T. Worsnop: Advanced Practical Physics for Students

9. Michael Nelson and J. M. Ogborn: Advanced level Physics Practicals

Suggested Online Link:

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

Suggested Continuous Evaluation (25 Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

DIPLOMA IN APPLIED PHYSICS		
Programme: ***Diploma in Applied Physics***	**Year: II**	**Semester: III/IV**
Subject: Physics		
Course Code:	**Course Title: Optoelectronic Devices**	

Credits: 04	**Minor/Elective**
Max. Marks: 100 **External Exam: 75** **Internal Assessment: 25**	**Min. Passing Marks: 33**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0	

Unit	Topic	No. of Lectures
Unit I	**Properties of semiconductors** Electron and photon distribution: density of states, effective mass and band structure, effect of temperature and pressure on band gap, recombination processes. Basics of semiconductor optics: Dual nature of light, band structure of various semiconductors, light absorption and emission, photoluminescence electroluminescence, radioactive and non-radiative recombination, wave trains.	**15**
Unit II	**Semiconductor light-emitting diodes and Semiconductor lasers** Structure and types of LEDs and their characteristics, guided waves and optical modes, optical gain, confinement factor, internal and external efficiency, semiconductor heterojunctions, double hetero structure LEDs. Semiconductor lasers: Spontaneous and stimulated emission, principles of a laser diode, threshold current, effect of temperature, design of an edge-emitting diode, emission spectrum of a laser diode, quantum wells, quantum-well laser diodes.	**15**
Unit III	**Semiconductor light modulators** Modulating light (direct modulation of laser diodes, electro-optic modulation, acousto-optic modulation), isolating light (magneto-optic isolators), inducing optical nonlinearity (frequency conversion, switching)	**15**

Unit IV	**Semiconductor light detectors** I-V characteristics of a p-n diode under illumination, photovoltaic and photoconductive modes, load line, photocells and photodiodes, pi-n photodiodes, responsivity, noise and sensitivity, photodiode materials, electric circuits with photodiodes, solar cells.	**15**

Suggested Reading:

1. Semiconductor Optoelectronics: Physics and Technology, Jasprit Singh, McGraw HillCompanies, ISBN 0070576378
2. Optoelectronics, E. Rosencher and B. Vinter, Cambridge Univ. Press, ISBN 052177813.
3. Photonic Devices, J. Liu, Cambridge Univ. Press, ISBN 0521551951.
4. Semiconductor Optoelectronic Devices 2nd Edition", P. Bhattacharya, Prentice Hall, ISBN 0134956567.
5. Physics of Semiconductor Devices, by S. M. Size (2nd Edition, Wiley, New York, 1981)

Suggested Online Link:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL),

https://www.youtube.com/user/nptelhrd

3. Swayam Prabha - DTH Channel,

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

Suggested Continuous Evaluation (25 Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

DIPLOMA IN APPLIED PHYSICS		
Programme: ***Diploma in Applied Physics***	**Year: II**	**Semester: III/IV**
Subject: Physics		
Course Code:	**Course Title: Opto-Electronics and Laser Instrumentation**	

Credits: 04	**Minor/Elective**
Max. Marks: 100 **External Exam: 75** **Internal Assessment: 25**	**Min. Passing Marks: 33**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0	

Unit	Topic	No. of Lectures
Unit I	**Introduction** Characteristics of optical radiation, luminescence, irradiance – Optical Sources – Photo Detectors – Opto-couplers and their application in analog and digital devices. Optical Fiber Fundamentals – modes, types of optical fibers – fiber coupling – Fiber optic sensors for common industrial parameters – V, I pressure, temperature – IR sources and detectors – fiber optic gyroscope.	**15**
Unit II	**Characteristics of LASERS** Einstein's equations – population inversion two, three and four level system Laser rate equation, properties – modes – Resonator configurations – Q switching and mode locking, cavity dumping, single frequency operation – Types of Lasers. Applications – Lasers for measurement of distance and length, velocity, acceleration, atmospheric effects, pollutants.	**15**
Unit III	**Applications** Lasers for measurement of distance and length, velocity, acceleration atmospheric effects, pollutants. Material processing applications – Laser heating, melting, scribing, splicing, welding and trimming of materials, removal and vaporization.	**15**
Unit IV	**Holographic Interferometry and Applications** Holography for non-destructive testing – medical applications – lasers and tissue interaction -surgery – dermatology.	**15**

Suggested Reading

1. Wilson and Hawkes, "Opto Electronics-An Introduction", Third Edition, Pearson Education, 1998.
2. John Ready, "Industrial Applications of Lasers", Second Edition, Academic Press, 1997.
3. Bhattacharya P, "Semiconductor Optoelectronics", Second Edition, Pearson Education, 1998.
4. Djafar K. Mynbaev, Lowell L. Scheiner, "Fiber-Optic Communications Technology", First Edition, Prentice Hall of India Pvt. Limited, 2000.
5. R. P. Khare, "Fiber Optics and Optoelectronics", Oxford Press, 2004.

Suggested Online Link:

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

Suggested Continuous Evaluation (25 Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

DIPLOMA IN APPLIED PHYSICS		
Programme: ***Diploma in Applied Physics***	**Year: II**	**Semester: III/IV**
Subject: Physics		
Course Code:	**Course Title: Classical Dynamics**	

Credits: 04	**Minor/Elective**
Max. Marks: 100 **External Exam: 75** **Internal Assessment:25**	**Min. Passing Marks: 25**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0	

Unit	Topic	No. of Lectures
Unit I	**Classical Mechanics of Point Particles** Review of Newtonian Mechanics; Generalized coordinates and velocities Hamilton's principle, Lagrangian and the Euler-Lagrange equations, one-dimensional Simple Harmonic Oscillations and falling body in uniform gravity; applications to simple systems such as coupled oscillators Canonical momenta & Hamiltonian. Hamilton's equations of motion. Applications: Hamiltonian for a harmonic oscillator, particle in a central force field	**15**
Unit II	**Small Amplitude Oscillations** Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude oscillations about the minimum, normal modes of oscillations example of N identical masses connected in a linear fashion to (N -1) - identical springs.	**15**
Unit III	**Special Theory of Relativity** Postulates of Special Theory of Relativity. Lorentz Transformations Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, length contraction and twin paradox. Four-vectors: space-like, time-like and light-like. Four-velocity and acceleration Metric and alternating tensors. Four-momentum and energy-momentum relation. Doppler effect from a four-vector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle.	**15**
Unit IV	**Fluid Dynamics** Density and pressure in a fluid, an element of fluid and its velocity, continuity equation and mass conservation, stream-lined motion, laminar flow, Poiseuille's equation for flow of a liquid through a pipe, Navier-Stokes	**15**

	equation, qualitative description of turbulence, Reynolds number, Basic physics of fluids: Definition of a fluid- shear stress; Fluid, properties- viscosity, thermal conductivity, mass diffusivity, other fluid properties and equation of state; Flow visualization - streamlines, pathlines, Streaklines	

Suggested Reading

1. H. Goldstein: Classical Mechanics
2. N.C. Rana & P. S. Jog: Classical Mechanics
3. Landau and Lifshitz: Mechanics
4. Sommerfeld: Mechanics
5. Whittaker: Analytical Dynamics of Particles and Rigid Bodies
6. Raychaudhuri: Classical Mechanics

Suggested Online Link:

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

Suggested Continuous Evaluation (25 Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

DEGREE IN APPLIED PHYSICS			
Programme: ***Degree in Applied Physics***		**Year:III**	**Semester: V Paper I**
Subject: Physics			
CourseCode:	**CourseTitle:** Solid State Physics		

Credits:04	**Core/Compulsory**
Max.Marks:100 **ExternalExam:75** **InternalAssessment:25**	**Min.PassingMarks:33**
TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):4-0-0	

Unit	Topic	No. of Lectures
Unit I	**Crystal Structure** Amorphous and Crystalline Materials. Lattice and Basis. Types of Lattices. Bravais lattices, Unit Cell. Primitive and non-primitive lattice, Symmetry elements, point group and space group, Simple structure of Sodium chloride (fcc), Cesium chloride (bcc), hcp, packing fraction of sc, fcc, bcc and hcp, Miller Indices.	**10**
Unit II	**Reciprocal Lattice:** Reciprocal lattice, Brillouin Zones. Reciprocal lattice and Brillouin Zone of sc, fcc and bcc structure, Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor. Extinction conditions of diffraction for sc, bcc and fcc lattice, Experimental methods of crystal structure determination-Laue, single crystal and powder method.	**15**
Unit III	**Elementary Lattice Dynamics:** Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T3 law	**10**
Unit IV	**Crystal Binding and Elastic Properties:** Ionic, covalent, metallic and hydrogen bond, Analysis of stress and strain, Elastic compliance and stiffness constant, elastic constant for cubic crystal, Elastic waves and velocity in cubic crystal with example of 100 direction, Experimental determination of elastic constants	**10**
Unit V	**Magnetic Properties of Matter:** Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia – and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss	**15**

Reference Books:

- Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
- Solid State Physics, Neil W. Ashcroft and N. David Mermin, 1976, Cengage Learning
- Solid-state Physics, H.Ibach and H Luth, 2009, Springer
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications
- NPTEL (http://nptel.ac.in)
- Virtual Labs (http://www.vlab.co.in)

Suggested OnlineLink:

1. MITOpenLearning-MassachusettsInstituteofTechnology,https://openlearning.mit.edu/
2. NationalProgrammeonTechnologyEnhancedLearning(NPTEL),htt ps://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel,https://www.swayamprabha.gov.in/index.php/program/curr ent_he/8

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

Suggested Continuous Evaluation (25Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

CoursePrerequisites: Passed Semester IV.

DEGREE IN SCINCE		
Programme: ***Degree in Science***	**Year: III**	**Semester: V Practical (Lab)**
Subject: Physics Practical (Lab)		
Course Code:	**Course Title:** Demonstrative Aspects of Solid State Physics (Practical)	

Course Outcomes:

1. To understand the magnetic properties of materials.
2. To measure the band gap of semiconductor.
3. To familiar with SCR & UJT.
4. To understand the characteristics of light emitting diode.

Credits: 02	**Core Compulsory**
Max. Marks: 50 **Internal (Record File): 15** **External Practical Exam: 20** **External Viva Voce : 15**	**Min. Passing Marks:17**

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

Unit	**Topic**	**No. of Lectures**
	Lab Experiment List	
	1. Measurement of Energy Band Gap of given semiconductor. 2. To measure the Magnetic susceptibility of Solids. 3. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis. 4. To find the corrosivity and retentivity of ferromagnetic sample. 5. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150 oC). 6. To determine the Hall coefficient of a semiconductor sample. 7. To study & evaluation of Stefan's law by thermal method. 8. To study the VI characteristic of SCR. 9. To study UJT trigger circuit for half wave and full wave control. 10. To study the characteristic of LED. 11. To show the effect of varying voltage and frequency on Hysteresis loop.	**60**

Suggested Readings:

1. M. Yadav, Practical Physics, Vol 3, KedarNath Ramnath Publication, 2023.
2. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962.
3. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015.
4. Indu Prakash: Practical Physics
5. S.L. Gupta, V. Kumar, "Practical Physics", PragatiPrakashan, Meerut, 2014.

Suggestive Digital Platforms / Web Links:

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

Suggested Continuous Evaluation Methods:

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

Record File (15 marks)

PREREQUISITE: Passed Semester IV.

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.

DEGREE IN SCIENCE

Programme: *Degree in Science*	**Year: III**	**Semester: V Paper-II**

Subject: Physics

Course Code:	**Course Title: Basic Electronics**

Course Outcomes:

1. Study of different Network Theorems for simplifying complicated electronics circuits.
2. Study of Regulated Power Supply. Understand different types of Rectifiers, Filters and Voltage Regulator.
3. Study of different types of special diodes and their applications
4. Study of Transistors and their applications in different types of Amplifiers.

Credits: 04	**Core Compulsory**
Max. Marks: 100 **External Exam: 75** **Internal Exam: 25**	**Min. Passing Marks: 33**

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

Unit	Topic	No. of Lectures
UnitI	**Network Theorems:** Constant voltage and constant current source, Conversion of voltage source into current source and vice-versa, Superposition theorem, Thevenin's theorem and procedure for finding Thevenin equivalent circuit, Norton's theorem and procedure for finding Norton equivalent circuit, Reciprocity theorem, maximum power transfer theorem, Applications of network theorems	**7**
UnitII	**Semiconductor Diodes:** Intrinsic and extrinsic semiconductors, P and N type semiconductors, Barrier formation in PN junction diode, qualitative idea of current flow mechanism in forward and reverse biased diode, PN junction and its characteristics, Static and dynamic resistance, Special diodes: Tunneling effect (Tunnel diode), Zener diode, Varactor diode, Point contact diode, V-I characteristic of these diodes, Principle and structure of Opto-electronic devices: LED, Photodiode, Solar cell.	**15**
UnitIII	**Power Supplies:** Block diagram of power supply (regulated and unregulated), Diode as a rectifier: Half and Full wave rectifiers, Bridge rectifiers, Peak inverse voltage, Efficiency, Ripple factor, Filters: Low pass and High pass filters, Band pass and Band stop filters, L and π – filters (Series inductor, Shunt capacitor, LC, CLC filters), Zener diode as a voltage regulator.	**8**
UnitI IV	**Transistors** N-P-N and P-N-P transistors, Transistor currents, Characteristics of CB, CE and CC, Current gains α, β and γ, Relations between α, β and γ, Basic CE amplifier circuit, Load Line analysis of transistors, DC Load line and Q-point, performance of	**15**

	transistor amplifier in CE mode: Input resistance, Output resistance, Effective collector load, Current, Voltage and Power gains, Active, Cutoff, and Saturation regions, Basic Idea of FET, MOSFET, & UJT.	
UnitI V	**Transistor Amplifiers:** Transistor biasing: Needs and requirements, Stability factor, Fixed-bias circuit, Collector to base bias circuit, Bias circuit with emitter resistor, Voltage divider biasing circuit, Single-stage transistor amplifiers, Common base (CB), Common emitter (CE) and Common collector (CC) amplifier, Comparison of a amplifier configurations. Amplifier classification based on biasing condition, Basic Idea of Power amplifiers (Class A, Push Pull amplifier, Class B and Class C), RC-coupled two stage amplifier and its frequency response.	**15**

SuggestedReading

1. M. K Baagde, S. P. Singh and Kamal Singh: Elements of Electronics
2. B. L. Theraja: Basic Electronics
3. V. K. Mehta: Elements of Electronics
4. J. D. Ryder: Networks, Lines and Fields
5. J. D. Ryder: Electronic Fundamentals and Applications.
6. Millman and Halkias: Integrated Electronics

Suggested OnlineLink:

4. MITOpenLearning-MassachusettsInstituteofTechnology,https://openlearning.mit.edu/
5. NationalProgrammeonTechnologyEnhancedLearning(NPTEL),htt
ps://www.youtube.com/user/nptelhrd
6. SwayamPrabha - DTH
Channel,https://www.swayamprabha.gov.in/index.php/program/curr
ent_he/8

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

Suggested Continuous Evaluation(25Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

Course Prerequisites: Passed SemesterIV.

DEGREE IN SCINCE		
Programme: ***Degree in Science***	**Year: III**	**Semester: V Practical (Lab)**
Subject: Physics Practical (Lab)		
Course Code:	**Course Title:** Demonstrative Aspects of Basic Electronics (Practical)	

Course Outcomes:

1. Experimental physics has the most striking impact on the industry wherever the instruments are used to study the Electronics and its application in industry and research.

2. Measurement precision and perfection is achieved through Lab Experiments.

Credits: 02	**Core Compulsory**
Max. Marks: 50 **Internal (Record File): 15** **External Practical Exam: 20** **External Viva Voce : 15**	**Min. Passing Marks:17**

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

Unit	**Topic**	**No. of Lectures**
	Lab Experiment List	
	1. To study characteristics of R-C coupled Amplifier with and without feedback. 2. To study the characteristics of integrating and differentiating circuit. 3. To draw the characteristics of P-N junction diode. 4. To draw the characteristics of PNP and NPN junction transistor. 5. Measurements of h-parameters of a transistor. 6. Study of different types of Rectifiers and Filters. 7. Verification of Network theorems. 8. Child Langmuir law. 9. Study of power supply (Ripple factor). 10. Study of Zener diode and regulation (taking different source voltage and loads). 11. Phase measurement using a C.R.O. 12. Study characteristics of Transformr coupled Amplifier with and without feedback	**60**

Suggested Readings:

1. M. Yadav, Practical Physics, Vol 3, KedarNath Ramnath Publication, 2023.
2. B.L. Worsnop, H.T. Flint, “Advanced Practical Physics for Students”, Methuen & Co., Ltd., London, 1962.
3. S. Panigrahi, B. Mallick, “Engineering Practical Physics”, Cengage Learning India Pvt. Ltd., 2015.
4. Indu Prakash: Practical Physics
5. S.L. Gupta, V. Kumar, “Practical Physics”, PragatiPrakashan, Meerut, 2014.

Suggestive Digital Platforms / Web Links:

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

Suggested Continuous Evaluation Methods:

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

Record File (15 marks)

PREREQUISITE: Passed Semester IV.

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.

DEGREE IN APPLIED PHYSICS			
Programme: ***Degree in Applied Physics***		**Year:III**	**Semester:VI Paper I**
Subject: Physics			
Course Code:	**Course Title: Modern Physics & Elementary Quantum Mechanics**		
Credits:04		**Core Compulsory**	
Max. Marks:100 **External Exam:75** **Internal Assessment:25**		**Min. Passing Marks:33**	
Total No. of Lectures-Tutorials-Practical (in hours per week):4-0-0			

Unit	Topic	No. of Lectures
Unit I	Thomson model, Rutherford model, Bohr model and spectra of hydrogen atoms, Shortcomings of these models, Bohr-Sommerfeld's model, Stern-Gerlach Experiment, Bohr magneton, Larmor's precession, Vector atom model, Spatial quantization and electron spin.	**10**
Unit II	Optical spectra and spectral notations, L-S and J-J coupling, selection rules and intensity rules, Explanation of fine structure of sodium D line, Normal Zeeman effect, X-ray spectra (Characteristic and continuous), Moseley's law.	**10**
Unit III	Origin of Quantum theory, Failure of Classical Physics to explain the phenomena such as Black body spectrum, Photoelectric effect, Characteristics and Einstein's explanation, Planck's quantum hypothesis, Planck's constant and light as a collection of photons; Compton scattering	**10**
Unit IV	De Broglie hypothesis of matter waves and De Broglie wavelength; Davisson-Germer experiment, Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle-impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle.	**15**
Unit V	Schrodinger's equation (Time independent and Time dependent), Postulates of Quantum Mechanics, Properties of Wave Function, Physical interpretation of Wave Function, Probability and probability current densities in three dimensions; Conditions for Physical acceptability of Wave Functions, Normalization, Eigenvalues and Eigenfunctions, Operator, position, momentum and Energy operators; Expectation values, Wave Function of a Free Particle.	**15**

SuggestedReading

1. Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill.
2. Modern Physics, John R. Taylor, Chris D. Zafiratos, Michael A .Dubson,2009, PHI Learning.
3. Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A. Moore, 2003, McGraw Hill.

4. Modern Physics, R. A. Serway, C. J. Moses, and C. A. Moyer, 2005, Cengage Learning.
5. A Text book of Quantum Mechanics, P. M. Mathews & K. Venkatesan, 2nd Ed., 2010, McGraw Hill
6. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2ndEdn., 2002, Wiley.
7. Quantum Mechanics, Leonard I. Schiff, 3rdEdn. 2010, Tata McGraw Hill.
8. Quantum Mechanics, G. Aruldhas, 2ndEdn. 2002, PHI Learning of India.

Suggested OnlineLink:

4. MITOpenLearning-MassachusettsInstituteofTechnology,https://openlearning.mit.edu/
5. NationalProgrammeonTechnologyEnhancedLearning(NPTEL),https://www.youtube.com/user/nptelhrd
6. SwayamPrabha-DTHChannel,https://www.swayamprabha.gov.in/index.php/program/current_he/8

SuggestedContinuousEvaluation(25Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

DEGREE IN SCINCE			
Programme: ***Degree in Science***		**Year: III**	**Semester: VI Practical (Lab)**
Subject: Physics Practical (Lab)			
Course Code:	**Course Title:** Demonstrative Modern Physics & Elementary Quantum Mechanics (Practical)		
Course Outcomes: **1.** Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the modern physics concepts. **2.** Measurement precision and perfection is achieved through Lab Experiments.			
Credits: 02		**Core Compulsory**	
Max. Marks: 50 **Internal (Record File): 15** **External Practical Exam: 20** **External Viva Voce : 15**		**Min. Passing Marks:17**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-4			
Unit	**Topic**		**No. of Lectures**
	Lab Experiment List		
	1. Frank-Hertz Experiment. 2. Determination of 'h' Planck's constant by Photoelectric effect. 3. 'e/m' by Thomson method. 4. 'e/m' Magnetron method. 5. 'e/m' Helical method 6. To determine the Planck's constant using LEDs of at least 4 different colours. 7.To determine the wavelength of laser source using diffraction of single slit. 8.To determine the wavelength of laser source using diffraction of double slits. 9. Determination of Ionization Potential using thyratron valve. 10. Inverse square law. 11. Verification of Cauchy Formula		**60**

Suggested Readings:

1. M. Yadav, Practical Physics, Vol 3, KedarNath Ramnath Publication, 2023.
2. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962.
3. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015.
4. Indu Prakash: Practical Physics
5. S.L. Gupta, V. Kumar, "Practical Physics", PragatiPrakashan, Meerut, 2014.

Suggestive Digital Platforms / Web Links:

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

Suggested Continuous Evaluation Methods:

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

Record File (15 marks)

PREREQUISITE: Passed Semester IV.

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.

DEGREE IN SCIENCE

Programme: *Degree in Science*	**Year: III**	**Semester: VI Paper-II**

Subject: Physics

Course Code:	**Course Title: Analog and Digital Electronics**

Course Outcomes:

1. Study of feedback in amplifiers along with their advantages and disadvantages.
2. Study of different types of oscillators.
3. Understand the concepts of Boolean Algebra and various number systems
4. Study of logic gates and their applications.

Credits: 04	**Core Compulsory**
Max. Marks: 100 **External Exam: 75** **Internal Assessment: 25**	**Min. Passing Marks: 33**

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

Unit	Topic	No. of Lectures
UnitI	**FeedbackAmplifiers** Concept of feedback in amplifier, Types of feedback, Voltage gain of feedback amplifier, Advantages of negative feedback, Gain stability, Decreased distortion, Increased bandwidth, Increase in input impedance, Decrease in output impedance, Amplifier circuits with negative feedback, Advantage of positive feedback.	**10**
UnitII	**Oscillators** Classification of oscillators, Frequency of oscillating current, Frequency stability of an oscillator, Essential of a feedback LC oscillator, Tuned base oscillator, Tuned collector oscillator, Hartley oscillator, Colpitt oscillator, Clapp oscillator, Tunnel diode oscillator, Crystal oscillator, Phase shift oscillator, Wien bridge oscillator, Relaxation oscillator, Astable, monostable and bistable multivibrator, Schmitt trigger, Saw-tooth generator.	**15**
UnitIII	**Operational Amplifiers (Black box approach):** Characteristics of an ideal and practical Op-Amp (IC-741), Open-loop & closed-loop gain. CMRR, Concept of virtual ground. applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Zero crossing detector	**10**

UnitIV	**Number System:** Decimal, Binary, Octal and Hexadecimal number systems, Inter-conversion of different number systems, Binary addition and subtraction, unsigned binary numbers, Sign-magnitude numbers, Complement of a number (1's complement and 2's complement), BCD, GREY, EXCESS-3 codes.	**10**
UnitV	**Logic Gates and Boolean Algebra:** Positive and negative logic, AND, OR and NOT gates (Realization using diodes and transistor), NAND and NOR Gates as universal gates, XOR and XNOR gates. De Morgan's theorems, Boolean laws, Simplification of logic circuit using Boolean algebra, Fundamental products, Minterms and maxterms, Conversion of a truth table into an equivalent logic circuit by (1) Sum of products method and (2) Karnaugh map, Half adder, Full adder and Subtractor, 4-bit binary adder-Subtractor.	**15**

Suggested Reading

1. M.K. Baagde, S.P. Singh and Kamal Singh : Elements of Electronics
2. B.L. Theraja : Basic Electronics
3. V.K. Mehta : Elements of Electronics
4. J.D. Ryder : Networks, Lines and Fields
5. J.D. Ryder : Electronic Fundamentals and Applications.
6. Millman and Halkias : Integrated Electronics

Suggested Online Link:

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

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

Suggested Continuous Evaluation (25 Marks):

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

Class Test/Assignment/ attendance- (10+10+5)

Course Prerequisites: Passed Semester V

DEGREE IN SCINCE		
Programme: ***Degree in Science***	**Year: III**	**Semester: VI Practical (Lab)**
Subject: Physics Practical (Lab) **(Practical)**		
Course Code:	**Course Title:** Demonstrative Aspects of Analog and Digital Electronics (Practical)	
Course Outcomes: **1.** Experimental physics has the most striking impact on the industry wherever the instruments are used to study the Electronics and its application in industry and research. **2.** Measurement precision and perfection is achieved through Lab Experiments.		
Credits: 02	**Core Compulsory**	
Max. Marks: 50 **Internal (Record File): 15** **External Practical Exam: 20** **External Viva Voce : 15**	**Min. Passing Marks: 17**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-4		

Unit	Topic	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 11. Study of Logic Gates 12. Verification of De Morgan's Theorem 13. Study of Half Adder 14. Study of Full Adder	**60**

Suggested Readings:

1. M. Yadav, Practical Physics, Vol 3, KedarNath Ramnath Publication, 2023.
2. B.L. Worsnop, H.T. Flint, “Advanced Practical Physics for Students”, Methuen & Co., Ltd., London, 1962.
3. S. Panigrahi, B. Mallick, “Engineering Practical Physics”, Cengage Learning India Pvt. Ltd., 2015.
4. Indu Prakash: Practical Physics
5. S.L. Gupta, V. Kumar, “Practical Physics”, Pragati Prakashan, Meerut, 2014.

Suggestive Digital Platforms / Web Links:

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

Suggested Continuous Evaluation Methods:

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

Record File (15 marks)

PREREQUISITE: Passed Semester V.

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.

National Education Policy-2020

Syllabus for Sri Dev Suman Uttarakhand University and All Affiliated Colleges for Post-Graduation in Physics.

2023

Year	Sem.	Course Code	Paper Title	Theory/ Practical	Credits
Bachelor (Research in Physics)					
FOURTH YEAR	VII		**Mathematical Physics**	Theory	(04)
			Classical Mechanics	Theory	(04)
			Quantum Mechanics	Theory	(04)
			Communication Electronics	Theory	(04)
			Practical	Practical	(04)
	VIII		**Atomic and Molecular Spectra**	Theory	(04)
			Electrodynamics	Theory	(04)
			Astrophysics/Elementary Particle Physics	Theory	(04)
			Condensed Matter Physics	Theory	(04)
			Elective Paper [one from the list] EL3**	Theory	(04)
			Practical	Practical	(04)
Master in Physics					
FIFTH YEAR	IX		**Advanced Quantum Mechanics**	Theory	(04)
			Computational Physics/Plasma Physics	Theory	(04)
			Advanced Electronics -I/Astrophysics -I/High Energy Physics-I/ Spectroscopy-I/ Condensed Matter Physics-I	Theory	(04)
			Advanced Electronics -II/Astrophysics -II/High Energy Physics-II/ Spectroscopy-II/ Condensed Matter Physics-II	Theory	(04)
			Practical	Practical	(04)
	X		**Nuclear Physics**	Theory	(04)
			Digital Electronics and Computer Architecture	Theory	(04)
			Advanced Electronics -III/Astrophysics -III/High Energy Physics-III/ Spectroscopy-III/ Condensed Matter Physics-III	Theory	(04)
			Advanced Electronics -IV/Astrophysics -IV/High Energy Physics-IV/ Spectroscopy-IV/ Condensed Matter Physics-IV	Theory	(04)
			Practical	Practical	(02)

****Elective (04 Credit, one from the list EL3) To be opted in Semester VIII**	
1.	**Statistical Physics**
2.	**Bio Physics**
3.	**Medical Physics**
4.	**Atmospheric Physics**
5.	**Nano Materials and Applications**

Subject prerequisites:
Bachelor in Science with Physics as major subject.

Programme Outcomes (POs):	
Students having Degree in ***Bachelor (Research in Physics)*** should have knowledge of advanced concepts of Physics and ability to apply this knowledge in various fields of academics, research and industry. They may pursue their future career in the field of academics, research and industry.	
PO1	Competence in the methods and techniques of calculations using Mathematical Physics, Classical Mechanics, Quantum Mechanics and Communication Electronics. It will develope an analytical skill on an advanced level and will enable the student to have mathematical tools to solve complex problems of Physics. The Programme will motivate the student to know more about the matter, the universe and the recent developments in the field of science. The student will have adequate knowledge to work for the industry,, consultancy, education, and research
PO2	The students would gain substantial knowledge in various branches of physics. The programme will enable the student to explore more in the field of his/her choice like Advanced Electronics, Spectroscopy, Astrophysics and High energy Physics. The student will be well equipped with the knowledge required for different organizations, industry, R& D sector.

Programme specific outcomes (PSOs):
PG IST YEAR/ **Bachelor (Research in Physics)**
Bachelor (Research in Physics) programme provides the student the adequate knowledge, general competence, and analytical skills on an advanced level, needed in industry, consultancy, education, research, or in government organisation.

Programme specific outcomes (PSOs):
PG IIND YEAR/ **Master in Physics**
• The Master of Science in Physics programme provides student the adequate knowledge to use mathematical tools to solve complex physical problems and have the solid background and experience needed to analyze and solve advanced problems in physics. • This course would enable the student to acquire scientific skills and the practical knowledge by performing experiments in general physics and electronics. • The student would also get some research oriented experience by doing theoretical and experimental projects in the last semester under the supervision of faculty. • The course as a whole opens up several career doors for the students interested in various areas of science and technology in private, public and government sectors. Students may get job opportunities in higher education, research organizations, physics consultancy and many others. Some of the institutions where physics students can start their career are: BARC, DRDO, NPTC, IISc, ISRO, ONGC, BHEL, PRL, NPL, SINP, VECC, IITs, NITs, IIPR etc.

Year wise Structure of PG in Physics (Core and Elective Courses a

Subject: Physics

Course/Entry-Exit Levels	Year	Sem.	Paper I	Credit/hrs	Paper II	Credit/hrs	Paper III	Credit/hrs	Paper IV	Credit/hrs	Paper V	Credit/hrs
Bachelor (Research in Physics)	IV	VII	**Mathematical Physics**	4/60	**Classical Mechanics**	4/60	**Quantum Mechanics**	4/60	**Communication Electronics**	4/60		
		VIII	**Atomic and Molecular Spectra**	4/60	**Electrodynamics**	4/60	**Elementary Particle Physics**	4/60	**Condensed Matter Physics**	4/60	**Elective Paper [one from the list] EL3****	**4/60**
Master in Physics	V	IX	**Advanced Quantum Mechanics**	4/60	**Plasma Physics**	4/60	**Advanced Electronics - I/Astrophysics -I/High Energy Physics-I/ Spectroscopy-I**		**Advanced Electronics - II/Astrophysics -II/High Energy Physics-II/ Spectroscopy -II**	4/60		
		X	**Nuclear Physics**	4/60	**Digital Electronics and Computer Architecture**	4/60	**Advanced Electronics - III/Astrophysics -III/High Energy Physics-III/ Spectroscopy-III**		**Advanced Electronics - IV/Astrophysics -IV/High Energy Physics-IV/ Spectroscopy -IV**	4/60		

Comments

Internal Assessment and External Assessment

	Internal Assessments	**Mark**	**External Assessment**	**Marks**

DETAILED SYLLABUS FOR BACHELOR (RESEARCH IN PHYSICS)
OR
P.G FIRST YEAR

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VII/PAPER I
Subject: Physics		
Course code	Course Title: **Mathematical Physics**	

Course Outcomes

Students would be able to understand the mathematical methods essential for solving the advanced problems in physics. It would be helpful in the development of the ability to apply the mathematical concepts and techniques to solve the problems in theoretical and experimental physics. The knowledge of mathematical physics would be beneficial in further research and development as it serves as a tool in almost every branch of science and engineering Course.

Credits: 4	Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**	**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0	

UNIT	**TOPIC**	**No. of Lectures**
UNIT I	Special Functions Series solution of differential equations, Legendre, Bessel, Hermite, and Laguerre differential equation and related polynomial, physical integral form of polynomials and their orthogonality relations. Generating Function and recurrence relation.	**15**
UNIT II	Curvilinear Coordinates and Tensors Curvilinear Coordinates and various operators in circular, cylindrical and spherical coordinate systems, classification of Tensors, Rank of a Tensor, covariant and contra-variant tensors, symmetric and anti-symmetric Tensors, Kronecker delta symbol. Contraction of Tensor, metric Tensor and Tensor densities, covariant differentiation and Geodesic equation (variational Method).	**15**
UNIT III	Complex Variables Function of complex variable, Cauchy's Riemann differential equation, Cauchy's integral theorem, residues and Cauchy's residues theorem, singularities, evolution of residues and definite integral.	**15**
UNIT IV	Integral Transforms Fourier integral and Fourier Transform, Fourier integral theorem, finite and infinite integral, Laplace transform of elementary function (Dirac delta & Green's function), Solution of simple differential equations.	**15**

Suggested Readings: B. S. Rajput: Mathematical Physics (Pragati Prakashan, Meerut) L. I. Pipes: Mathematical Physics (McGraw Hill) P. K. Chattopadhyay: Mathematical Physics (Wiley Eastern, New Delhi) Arfken.: Mathematical methods for Physics Harper Charlie: Introduction to Mathematical Physics Mathews and Walker: Mathematical Methods of Physics (Benjamin press) Horse and Feshbach : Methods of Theoretical Physics (McGraw Hill)	
Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Bachelor in Science with Physics as major subject**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VII/PAPER II
Subject: Physics		
Course code	Course Title: **Classical Mechanics**	
Course Outcomes: In this course students would learn to apply the Newtonian laws using various mathematical formulations to describe the motions of macroscopic objects using generalized coordinates, momentum, forces and energy. The classical mechanics would be helpful in understanding of advanced branches of modern physics.		
Credits: 4		Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**		**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		

UNIT	**TOPIC**	**No. of Lectures**
UNIT I	Mechanics of a System of Particles Constraints and generalized coordinates, D Alembert's principle, Lagrange equations for holonomic and non holonomic systems and their applications, conservation laws of linear momentum, energy and angular momentum.	**15**
UNIT II	Hamiltonian Formulation and Hamilton Jacobi Theory Hamiltonian equations of motion and their physical significance, Hamilton's principle, principle of least action, canonical transformations Hamilton-Jacobi theory, Poisson brackets, properties of Poisson bracket, Poisson's Theorem, Lagrange bracket.	**15**
UNIT III	Dynamics of a Rigid Bodies Motion of a rigid body, body and space Reference system, angular momentum and Inertia tensor, Principle axes- Principle moments of Inertia, spinning tops, Euler angles, Infinitesimal rotations.	**15**
UNIT IV	Central Force Problem Action and angle variables, phase integral, small oscillations, Kepler's laws of Planetary motion and their deduction, scattering in a Central field, Rutherford scattering cross section	**15**

Suggested Readings:

H. Goldstein: Classical Mechanics
N.C. Rana & P. S. Jog: Classical Mechanics
Landau and Lifshitz: Mechanics, Pergamon Sommerfeld : Mechanics, Academic Press

Whittaker: Analytical Dynamics of Particles and Rigid Bodies - Cambridge Raychaudhuri: Classical Mechanics, Oxford Bhatia: Classical Mechanics, Narosa. H.M. Agrawal: Classical Mechanics, New Age International	
Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Bachelor in Science with Physics as major subject**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VII/PAPER III
Subject: Physics		
Course code……	Course Title: **Quantum Mechanics**	

Course Outcomes:

The course provides an understanding of the behaviour of the systems at microscopic (atomic and nuclear) scale and even smaller. Students would learn basic postulates and formulations of quantum Mechanics. The course, in fact, plays an important role in explaining the behaviour of all physical systems in the universe. The course includes the study of a brief review of foundations of quantum mechanics, matrix formulation of quantum mechanics, symmetry in quantum mechanics and approximation methods for bound states.

Credits: 4	Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**	**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0	

UNIT	TOPIC	No. of Lectures
UNIT I	**Non-Relativistic Quantum Mechanics and Schrödinger Equation** Schrödinger's equation, Probability and current densities, continuity equation, physical interpretation of wave function, orthogonality of eigen functions, Principle of superposition, wave packet, normalization, Schrödinger's equation in three dimensions, centrally symmetric square well and harmonic potentials, harmonic oscillator and its wave functions, Hydrogen atom.	**15**
UNIT II	**Operator Formulation of Quantum Mechanics** State vectors and operators in Hilbert Space, Eigen values and Eigen vectors of an operator, Hermitian, Unitary and Projection operators, commuting operators, BRA and KET Notations, Postulates of Quantum Mechanics, co-ordinate Momentum and Energy representations, dynamical behavior, Heisenberg, Schrödinger and interaction Pictures	**15**
UNIT III	**Theory of Angular Momentum** Orbital Angular momentum operator, its eigen value and eigen functions, space quantization, spin angular momentum, Pauli's theory of spin, Addition of angular momentum, ClebschGordan coefficients	**15**
UNIT IV	**Approximation Methods** Time independent and Time dependent Perturbation Theory Stationary Perturbation, first and second order	**15**

	corrections, WKB approximation methods, connection formula and boundary conditions, Bohr Sommerfield quantization rule, Penetration of potential barrier, Time independent perturbation theory and its applications. Applications of time-dependent perturbation theory for constant perturbation, Fermi Golden rule, Coulomb excitation, Sudden and adiabatic approximation.	
Suggested Readings B. S. Rajput: Advanced Quantum Mechanics Schiff: Quantum Mechanics Thankppan: Quantum Mechanics Loknathan and Ghatak Quantum Mechanics		
Can be opted by **Bachelor in Science with Physics as major subject**		
Suggested Continuous Evaluation Methods:		
Course Prerequisites **Bachelor in Science with Physics as major subject**		
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8		

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VII/PAPER IV
Subject: Physics		
Course code……	Course Title: **Communication Electronics**	

Course Outcomes

This course helps the student to gain basic ideas of the fundamentals of communication systems. The course includes Modulation AM and FM (Transmission and reception), SSB transmission, AM detection, AGC, Radio receiver characteristics, FM transmitter, Propagation of Radio Waves ,Antenna , Fundamentals of image transmission,TV transmitter,Transmission Lines etc.The course may provide the opportunity to work in any organization related to communication.

Credits: 4	Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**	**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0	

UNIT	TOPIC	No. of Lectures
UNIT I	**Semiconductor devices:** Diodes, junctions, transistors, field effect devices, homo- and hetero-junction devices, device structure, device characteristics, frequency dependence and applications, optoelectronic devices (solar cells, photo-diode, LEDs, opto-coupler).	**15**
UNIT II	**Combinational Circuits:** Boolean algebra, canonical forms of Boolean functions, simplification of Boolean functions (K-map method, tabulation method), don't care conditions. adders & subtractors, encoders, decoders, multiplexers, demultiplexers, digital to analog and analog to digital converters.	**15**
UNIT III	**Sequential Circuits:** Memory element: RS (using NAND and NOR Gate), clocked RS, JK, JKMS, D-type, T-type and edge triggered flip flop; Registers: right, left and left-right both type shift registers; Counters: asynchronous & synchronous counters, binary & non binary counters (use of K- maps), shift counter (Johnson counter), ring counter.	**15**
UNIT IV	**Power Electronics:** Characteristics and applications of Silicon controlled rectifier, TRIAC, DIAC & UJT	**15**

Suggested Readings: 1. Electronic Principles'- A.P. Malvino, TMH Publishing Company Limited. 2. 'Digital Fundamentals'- T.L. Floyd, Universal Book Stall, New Delhi. 3. 'Digital Principles and Applications'- A.P. Malvino and D.P. Leach, TMH Publishing Company Limited. 4. 'Digital Design'- M. Mano, PHI Private Limited.	
Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Bachelor in Science with Physics as major subject**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VII/PAPER V
Subject: Physics		
Course code	Course Title: PRACTICAL	
Course Outcomes: Student would gain practical knowledge by performing various experiments of Electronics and Optics.		
Credits: 4		Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**		**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		

UNIT	**List of Experiments**	**No. of Lectures**
	Study of RC circuit with an AC source using phase diagrams. Absorption Spectrum of KMnO4 using Hilger-Nutting Photometer. Young's modulus by Interference method. NPN and PNP Transistor Characteristics with (a) Common base (b) Common emitter configurations/ h – parameter. Study of RC- coupled/ Transformer Coupled Amplifier. Study of B-H curve. Study of Amplitude Modulation /Demodulation. Verification of the Hartmann's Formula. Frank-Hertz experiment. e/m by Zeeman effect. Determination of susceptibility. Study of CRO. Velocity of Ultrasonic waves. Linear Air track. Leacher Wire	60

Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Bachelor in Science with Physics as major subject**	
Suggested Equivalent Online Courses: 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	

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VIII/PAPER I
Subject: Physics		
Course code……	Course Title: **Atomic and Molecular Spectra**	

Course Outcomes

The course structure includes atomic and molecular spectroscopy. As per the course structure, the students learn basics concepts of spectroscopic principles and rules. Students would learn technique in spectroscopy and know about their applications. The course is helpful for the students to explore R & D opportunities in various areas of science and technology such as biomedical, industrial and environmental fields.

Credits: 4	Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**	**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0	

UNIT	**TOPIC**	**No. of Lectures**
UNIT I	Fine structure of hydrogen spectrum, L-S and J-J coupling, Spectroscopic terms, Hund's rule and time reversal, Pauli's exclusion principle.	**15**
UNIT II	Alkali spectra, spin-orbit interaction and fine structure in alkali Spectra, Equivalent and non-equivalent electrons, Normal and anomalous Zeeman effect, Paschen Back effect, Stark effect, Hyperfine structure (qualitative).	**15**
UNIT III	Molecular spectra of diatomic molecules, Born Oppenheimer approximation, elementary idea of quantization of rotational and vibrational energy, rotational spectra for rigid and non rigid rotations, vibrational spectra (harmonic and an-harmonic), intensity and selection rules and molecular constants.	**15**
UNIT IV	Atomic Polarizability, Raman spectra, Quantum theory of Raman spectra, Determination of molecular structure, Electronic spectra, band system, Progression and sequences, band head formation, Condon parabola, Franck Condon Principle dissociation energy and its determination	**15**

Suggested Readings:

C. B. Banwell: Fundamentals of Molecular Spectroscopy

Walker and Stranghen: Spectroscopy Vol. I, II, & III G.M.

Barrow: Introduction to Molecular Spectroscopy Herzberg: Spectra of diatomic molecules

Jeanne L Mchale: Molecular Spectroscopy J. M. Brown: Molecular Spectroscopy P. F. Bemath: Spectra of atoms and molecules J. M. Holias: Modern Spectroscopy K. Thyagrajan and A.K. Ghatak: Lasers: Theory and applications A Yariv: Quantum Electronics M. D. Levenson: Intoduction to non-linear laser spectroscopy B. B. Laud: Laser and non-linear optics	
Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester VII with Physics as major**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VIII/PAPER II
Subject: Physics		
Course code……	Course Title: **Electrodynamics**	

Course Outcomes:

The study of electrodynamics provides basic foundation for the student to understand advance courses of physics. The course includes Basic equations of Electromagnetism, Electrostatics; Magnetostatics; Maxwell's equation, Four Vector Formalism of Maxwell's Equations Four vector potential, electromagnetic field tensor and Quantization of electromagnetic energy

Credits: 4	Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**	**Min. Passing Marks: 36**

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

UNIT	TOPIC	No. of Lectures
UNIT I	**Electromagnetism** Basic equations; Electrostatics; Magnetostatics; Different Systems of Units, Preliminary notations, four- vectors, Lorentz transformations, time, space and light like separations, Lorentz invariants, Energy and Momentum.	**15**
UNIT II	**Maxwell's Equations** Maxwell's equation, Displacement current, electromagnetic waves in conducting and nonconducting medium, Poynting theorem, boundary condition at the interface of conducting and non conducting media, propagation between parallel conducting plates. Electromagnetic wave equations	**15**
UNIT III	**Four Vector Formalism of Maxwell's Equations** Four vector potential, electromagnetic field tensor, Lorentz invariance, Lorentz force, covariant form of Maxwell's equations, four vector current, continuity equation, Gauge invariance of Maxwell equation, electromagnetic energy-momentum tensor, Motion of charge particle in electromagnetic field, Lorentz force	**15**
UNIT IV	**Electromagnetic Radiation** Lienard-Witchert potential, conventional potential, Quantization of electromagnetic energy (virtual photon), Radiation from an Accelerated Charge, Fields of an accelerated charge; angular and frequency distributions of the emitted radiation, special cases of acceleration parallel and perpendicular (circular orbit) to velocity; Larmor's	**15**

	formula and its relativistic Generalization; Bremstrahlung, Cerenkov radiation	
Suggested Readings Jackson: Classical electrodynamics; Wiley Eastern, New Delhi Landau and Lifshitz: Classical theory of fields; Pergameon Press Thide: Electromagnetic field Theory Panofsky and Phillips: Classical Electricity and Magnetism Landau &Lifshitz: Electrodynamics of Continuous Media		
Can be opted by **Bachelor in Science with Physics as major subject**		
Suggested Continuous Evaluation Methods:		
Course Prerequisites **Passed Semester VII with Physics as major**		
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8		

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VIII/PAPER III a
Subject: Physics		
Course code	Course Title: **Astrophysics**	

Course Outcomes

The course is important for the students to learn about the most fundamental building blocks of Universe and Solar system and hence to understand Stellar system.The course provides a platform for the students seeking research opportunities in Astrophysics.

Credits: 4	Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**	**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0	

UNIT	TOPIC	No. of Lectures
UNIT I	The universe and Solar System: Basic idea of universe and galaxies, Astronomical telescopes. The solar system. Classification of the Planets, Orbits, Laws of planetary motion. Physical features, surface features, Internal Structure. Atmosphere, Satellites and Rings. Asteroids, Meteors and Meteorites their types, Orbits: physical nature and composition. Origin of the minor planets, Observation of meteor showers and sporadic meteors Meteorite craters. Origin of Comets, Periodic comets, Physical nature, Spectra, Brightness variation. Gas production rates, dust and ion tails.	**15**
UNIT II	Stellar System: Sun as a Star: History of Sun, Sun's interior, the photosphere, the solar atmosphere (chromosphere & corona). Salient features of sunspots, sun's rotation & solar magnetic field, explanation for observed features of sunspots. Distances of stars from the trigonometric. Secular and moving cluster parallaxes. Stellar motions, Magnitude scale and magnitude systems. Atmospheric extinction. Absolute magnitudes and distance modulus. color index. The Hertzberg- Russell Diagram: The colour, Brightness or luminosity, the population of star. Elementary idea of Binary & Variable Stars. Nuclear fission, Nuclear fusion, condition for nuclear reaction in stars. Types of galaxies, Structure and features of the Milky Way Galaxy	**15**

UNIT III	Physics of the Stars: Apparent and Mean Position of stars. Effects of atmospheric refraction, aberration. parallax, precession, nutation and proper motion on the coordinates of stars. Reduction from apparent to mean places and vice versa. Spectra of Stars. Distribution of stars in space. Statistical parallaxes. Local standard of rest. Solar motion and its determination. Peculiar velocities. Single and Two-star stream hypothesis. Velocity ellipsoid. Comparison with solar neighbourhood. Bottlinger's diagram. HR diagram. HD and MK spectral classification of stellar spectra. Radiation laws and basic ideas on spectral line formation. Explanation of stellar spectra in terms of Boltzmann and Saha equations. Spectroscopic parallax	**15**
UNIT IV	Fundamental Equations: Equation of mass distribution. Equation of hydrostatic equilibrium. Equation of energy transport by radiative and convective processes. Equation of thermal equilibrium. Equation of state. Stellar opacity. Stellar energy sources. Stellar models: The overall problem and boundary conditions. Russell- Voigt theorem. Dimensional discussions of mass-luminosity law. Polytropic configurations. Homology transformations.	**15**
	Suggested Readings: 1. Principles of Stellar Dynamics, S. Chandrasekhar 2. The Great Universe, G K Sudarshan, S chand Publications. 3. Our Solar System, Joshi and Rana, New Age Publications 4. Galaxies and Universe, K.C. Freeman: 5 The Origin and Evolution of Galaxies, S.D. M. White: 6. Lecture notes on "Dynamics of Stellar Systems", S. M. Alladin: 7. Stars and Galaxies: K. D. Abhyankar (Tata McGraw Hill Publication) 8. Exploration of the Universe: G. Abell 9. The Structure of Universe: Jayant Naralikar 10.Physics of Comets: K.S. Krishnaswamy	

11. Our solar system: A.W. Joshi & N. Rana 12. Introduction to Astrophysics: Baidyanath Basu 13.Astrophysics of the Sun: Harold Zirin 14. The Quiet Sun: Gibson 15. Stellar Evolution: M. Schwarzschild 16. S. Chandrasekhar: Stellar Structure: S. Chandrasekhar 17.Principles of Stellar Interiors - Vol.I and II: Cox and Guili 18. White Dwarfs, Neutron Stars and Black Holes: Shapiro andTevkolsky.	
Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester VII with Physics as major**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VIII/PAPER III b
Subject: Physics		
Course code	Course Title: **Elementary Particle Physics**	

Course Outcomes

The course is important for the students to learn about the most fundamental building blocks of matter and radiation, interaction among elementary particles and hence to understand their behaviour. The course provides a platform for the students seeking research opportunities in high energy physics.

Credits: 4	Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**	**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0	

UNIT	TOPIC	No. of Lectures
UNIT I	Elementary Particles History of elementary particles, Classification of elementary particles, Fundamental interactions, Resonances, Lepton and Baryon number; Isospin, Strangeness, Hypercharge, Gell - Mann Nishijima relations, Symmetries and conservation laws, Parity, Time reversal and charge conjugation, Parity violation, CP violation in mesons, CPT invariance.	**15**
UNIT II	Unitary Symmetries and Application in the Physics of Elementary Particles Basics of unitary groups, fundamental representation of SU(2), SU(3) diagonal generators and weights, generators of SU(2) and U(2), weight diagram of fundamental representation of SU(2), generators of SU(3) and U(3), Weight of first fundamental representation of SU(3), shift operators, I, U, V spins, complete weight diagram for the (1 0), (0 1), (3, 0), (1 1) and (2 1) representations of SU(3) , Gell Mann Okubo Mass formula.	**15**
UNIT III	Method of Young Tableaux and its Applications Young Tableaux and unitary symmetry, standard arrangements of young tableaux, Dimentaionality of the representations of SU(N), Multiplets of SU(N-1), subgroup of SU(N), Baryon multiplets in different representations, general rule and its application for reducing kronecker product of two representations, kronecker product of three particle state vectors.	**15**
UNIT IV	Nuclear and Particle Detectors Basic principle of particle	**15**

	detectors, Ionization chamber, Proportional counter, Geiger-Muller Counter, Scintillation counters and-ray spectrometer, semiconductor detector, Nuclear emulsion technique, Cloud chamber, Bubble chamber	
Suggested Readings: D. H. Perkins: Introduction to High Energy Physics, Cambridge University Press, 2000 S. N. Ghoshal: Atomic and Nuclear Physics, S. Chand and Company Ltd, 1994 D. Griffiths: Introduction of Elementary Particles DB Lichtenberg: Unitary Symmetry and Elementary Particles, Academic Press, 1978 Hughes: Elementary Particles Blatt and Weiskopf: Theoretical Nuclear Physics FE Close: Quarks and Patrons P. P. Cheng and G. LF Li: Gauge Field Theory: W. E. Burcham: Nuclear Physics R. M. Singru: Introduction to experimental nuclear physics E. Segre: Experimental nuclear physics		
Can be opted by **Bachelor in Science with Physics as major subject**		
Suggested Continuous Evaluation Methods:		
Course Prerequisites **Passed Semester VII with Physics as major**		
Suggested Equivalent Online Courses: 4. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 5. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 6. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8		

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VIII/PAPER IV
Subject: Physics		
Course code	Course Title: **Condensed Matter Physics**	

Course Outcomes:

The students will be able to develop an understanding of the lattice, different types of crystal structures, symmetries. The student would gain insight about the interior of the substances using X-ray diffraction in crystals. This course also includes elastic waves, phonons, and lattice vibrational properties and also superconductivity. The course forms a theoretical basis of experimental material science and technology.

Credits: 4	Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**	**Min. Passing Marks: 3 6**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0	

UNIT	TOPIC	No. of Lectures
UNIT I	**Symmetry and Reciprocal Lattice:** Crystal symmetry elements, Miller indices, Direct lattice type, fundamental type of direct lattices i.e. 2 dimensional and 3 dimensional lattice, Diffraction of Waves by Crystal: The Bragg law, Fourier Analysis, Reciprocal lattice Vectors, Diffraction Condition. Brillouin Zones, Reciprocal lattice (example of sc, bcc, fcc, hcp lattices), Crystal structure factor (bcc, fcc), Atomic form factor, Scattering factors, Intensity of diffraction maxima, extinction due to lattice centering.	**15**
UNIT II	**Lattice Vibrations**: Concept of dispersion relation, quantization of lattice vibrations (Phonons), normal modes & normal coordinates, longitudinal and transverse modes of vibration, modes of vibration of monatomic and diatomic lattices. Density of states (Phonons).	**15**
UNIT III	**Free Electron theory of metals:** Free electron theory of metals, free electron gas in one dimensional box, free electron gas in three dimensional box-filling up of energy bands, Density of electron states, Fermi energy, Average kinetic energy of electron , average velocity.	**15**
UNIT IV	**Thermal properties of solids:** Specific heat of solids, Classical theory, Einstein theory, The Debye theory, Born's modification of the Debye theory. Heat capacity of diatomic lattices. Thermal conductivity. Lattice thermal conductivity. Phonon mean free path. Phonon-phonon scattering-the umklapp processes. Thermal Expansion. Origin of thermal expansion. Gruneisen relation	**15**

Suggested Readings A. J. Dekker: Solid State Physics Ashcroft and Mermin: Solid State Physics S.O. Pillai: Solid State Physics R. L. Singhal: Solid State Physics C. Kittle: Introduction to Solid State Physics Verma &Srivastava: Crystallography for Solid State Physics	
Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester VII with Physics as major**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VIII/PAPER V
Subject: Physics		
Course code	Course Title: PRACTICAL	

Course Outcomes:

The student will have adequate knowledge to perform the experiments of different fields of physics with clear understanding of the theory behind the experiment.

Student will know about various electronic components and learn to design some basic electronic circuits and study their applications.

Credits: 4	Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**	**Min. Passing Marks: 36**

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

UNIT	List of Experiments	No. of Lectures
	1. Study of the Phase measurement by superposition of voltages with LCR Circuits. 2. Study of different oscillators (Hartely, colpit, Weinbridge oscillators etc.). 3. Study of an electronically regulated power supply. 4. Study of negative Feed- back Amplifier. 5. Determination of wavelength (λ) and wavelength difference (Δλ) by Michelson Interferometer. 6. Study of different type of Resistances and Diodes. 7. Study of Photo Voltaic Cell. 8. Stefan's Constant 9. FET characteristics 10. Fresnel's Law 11. Cauchy Formula 12. Lattice Dynamic Kit 13. Study of Logic gates 14. Detection Efficiency of Diode 15. Fabry – Perot Interferometer 16. Four Probe method	**60**

Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Bachelor in Science with Physics as major subject**	
Suggested Equivalent Online Courses: 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	

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VIII EL3(1)
Subject: Physics		
Course code	Course Title: **Statistical Physics**	
Course Outcomes: The course structure includes different aspects of statistical Mechanics and Statistical models for phase transition. Study of this course will enable students a clear understanding of classical and Quantum Statistics.		
Credits: 4		Elective
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**		**Min. Passing Marks: 33**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		

UNIT	TOPIC	No. of Lectures
UNIT I	Foundation of Statistical Mechanics Microscopic and macroscopic states, Density of states, Micro-canonical, Canonical and grand canonical ensembles, Canonical ensemble and Gibb's distribution, Boltzmann–Planck method, Partition function and statistical definition of thermodynamic quantities, Computation of partition functions of some standard systems.	**15**
UNIT II	Statistical Properties System of linear harmonic oscillators in the canonical ensemble; Grand canonical ensemble and its partition function; Chemical potential; Partition function and distribution for perfect gas; Gibb's paradox; Free energy, entropy, Equation of state and specific heat determination of perfect gas.	**15**
UNIT III	Statistical models Theory of phase transitions, First order phase transition, Second order phase transitions and higher order phase transitions (elementary discussion), Ising model, One dimensional (with exact solution), Two dimensional (with exact solution) & three dimensional model (elementary idea), Landau theory of phase transition, Weiss theory of Ferro-magnetism, Heisenberg model. Virial equation of states.	**15**
UNIT IV	Quantum Statistics Bose-Einstein and Fermi- Dirac distributions, Degeneracy, Gas degeneration, Degenerate Bose gas, Bose Einstein condensation, Highly degenerate B-E and F-D gases; examples of Molecular Hydrogen, liquid helium and electron gas in metals.	**15**

Suggested Readings

Quantum Mechanics: A. S. Davidov
Quantum Mechanics: B. S. Rajput
Quantum Mechanics: Paul Roman
Theoretical Chemistry: Glastohn
Statistical Mechanics: Landau and Lifshitz
Statistical Mechanics: Pathira
Statistical Mechanics: Huang

Can be opted by

Bachelor in Science with Physics as major subject

Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester VII with Physics as major**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VIII EL3(2)
Subject: Physics		
Course code	Course Title: **Bio Physics**	

Course Outcomes:

Biophysics is the field that applies the theories and methods of physics to understand how biological systems work.The student"s knowledge can be used in the sector relater to health and Medical .

Credits: 4	Elective
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**	**Min. Passing Marks: 36**

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

UNIT	TOPIC	No. of Lectures
UNIT I	**Basic Concepts in Biophysics** Elementary ideas about the DNA structure, Forces stabilizing DNA and protein structure, sugar-phosphate backbone, nucleosides and nucleotides, three dimensional DNA structure, RNA. Proteins: primary, secondary, tertiary and quaternary structures, enzymes and their catalytic activity, DNA and protein folding, DNA denaturation, replication, mutation, intercalation, neurotransmitters, membranes.	**15**
UNIT II	**Technique for The Study of Biological Structure and Function** Application of experimental techniques of light scattering (tomography), FTIR and Raman spectroscopy, absorption and fluorescence spectroscopy/ microscopy, anisotropy, optical activity, circular dichroism, electrophoresis,.	**15**
UNIT III	**Photobiology** interaction of light with cell and tissues, Photosynthesis, human eye and vision optical biopsy, optical biosensors, Laser tweezers and Laser Scissors Photo-dimerization, Photodynamic therapy.	
UNIT IV	**Radiation Effects on Biological Systems** High doses received in a short time, Low-level doses limits, direct ionization of DNA, radiation damage to DNA, Biological effects (Genetic, Somatic, Cancer and sterlity). Bio-imaging: Ultrasound, MRI imaging, confocal fluorescence imaging and X-ray.	**15**

Suggested Readings:

Essentials of Biophysics: P. Narayanan.

Basic Molecular Biology: Price.

Quantum Mechanics of Molecular Conformations: Pullman (Ed.). Non-linear Physics of DNA: Yakushevich. Biological Physics: Nelson. Spectroscopy of biological systems Modern Spectroscopy: J.M. Hollas. Transmission Electron Microscopy of Metals: Gareth Thomas Elements of X-ray Diffraction: Bernard Dennis Cullity.	
Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester VII with Physics as major**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VIII EL3(3)
Subject: Physics		
Course code	Course Title: **Medical Physics**	

Course Outcomes:

Medical Physics is a branch of science that uses the methods of physics to study biological processes and also working of the instruments and machines used in Medical Science .Physics uses mathematical laws to explain the natural world, and it can be applied to biological organisms and systems to gain insight into their workings. The course includes Physics of Respiratory and Cardiovascular System, Electricity in the Body and Sound/Light and also Equipment's and Modern Medicines .The course opens future prospects of the student in the field of Medical Science .

Credits: 4	Elective
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**	**Min. Passing Marks: 36**

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

UNIT	TOPIC	No. of Lectures
UNIT I	**Mechanics of Human Body** Static, Dynamic and Frictional forces in the Body, Composition, properties and functions of Bone, Heat and Temperature, Temperature scales, Clinical thermometer, Thermography, Heat therapy, Cryogenics in medicine, Heat losses from Body, Pressure in the Body, Pressure in skull, Eye and Urinary Bladder.	**15**
UNIT II	**Physics of Respiratory and Cardiovascular System** Body as a machine, Airways, Blood and Lungs interactions, Measurement of Lung volume, Structure and Physics of Alveoli, breathing mechanism, Airway resistance, Components and functions of Cardiovascular systems, work done by Heart, Components and flow of Blood, Laminar and Turbulent flow, blood Pressure, direct and indirect method of measuring, Heart sounds.	**15**
UNIT III	**Electricity in the Body and Sound/Light In Medicine** Nervous system and Neuron, Electrical potentials of Nerves, Electric signals from Muscles, Eye and Heart, Block diagram and working to record EMG, Normal ECG wave form, Electrodes for ECG, Amplifier and Recording device, Block diagram and working to record ECG, Patient monitoring, Pace maker. General properties of sound, Stethoscope, Generation, detection and characteristics of Ultrasound, Ultrasound imaging technique, A scan and B scan methods of ultrasound imaging,	**15**

	properties of light, Applications of visible UV, IR light, and Lasers in medicine, Microscope, Eye as an optical system, Elements of the Eye, Ophthalmology Instruments.	
UNIT IV	**Diagnostic X-Rays and Nuclear Medicine** Production and properties of X-rays, Basic Diagnostic X-ray Machine, X-ray image, Live X-ray image, X-ray computed Tomography, Characteristics of Radio activity, Radioisotopes and Radio nuclides, Radioactivity sources for Nuclear medicine, Basic Instrumentation and clinical applications, Principles of Radiation Therapy, Nuclear medicine imaging devices, Radiation sources.	**15**
Suggested Readings: Medical Physics by Department of Physics, St. Joseph's College, Trichy-2. Medical Physics by John R. Cameron and James G. Skofronick, John Wiley & Sons. Hand book of Biomedical Instrumentation : R.S.Khandpur, Tata McGraw Hill Publication Co., Delhi, 1987.		
Can be opted by **Bachelor in Science with Physics as major subject**		
Suggested Continuous Evaluation Methods:		
Course Prerequisites **Passed Semester VII with Physics as major**		
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8		

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTERVIIIE L3(4)
Subject: Physics		
Course code	Course Title: **Atmospheric Physics**	

Course Outcomes:

The course introduces students to Earth- Atmosphere and Meteorology The course includes Environmental pollution and climate change etc. The course is useful for the students who want to work in Metereological department or wants to pursue his/her career in the field of environmental science . The course is also very important for R& D purposes.

Credits: 4	Elective
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**	**Min. Passing Marks: 33**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0	

UNIT	TOPIC	No. of Lectures
UNIT I	**Introduction to Earth Atmosphere and Meteorology** Elementary concept of atmospheric sciences, atmosphere and it composition, Thermal and pressure variation in earth atmosphere, Thermal structure of the troposphere, stratosphere, mesosphere and ionosphere, Hydrostatic equation, spectral distribution of the solar radiation, Green house effect and effective temperature of earth. Meteorological process and different system, local winds, monsoons, fogs, clouds, precipitation, Cyclones and anti-cyclones, thunderstorms, Mountain Meteorology	**15**
UNIT II	**Atmospheric Dynamics and Thermodynamics** Introduction to atmospheric dynamics, Basic conservation laws, Applications of the basic equations, circulations and vorticity, Atmospheric oscillations, The general circulations, Tropical dynamics, Thermodynamical considerations, Adiabatic and isothermal processes, equation of state for dry and moist air, Humidity parameters, laws of thermodynamics, Entropy, Thermodynamic diagram and their uses.	**15**
UNIT III	**Environmental pollution and climate change** Atmospheric pollution, type of pollutants, various sources of emissions, Trace gages, Production and loss processes of stratosphere ozone, Tropospheric ozone, Role of trace gases and their budget, motion of air-masses (back-air trajectory), tools for modeling (Box model and 3-D model), Atmospheric aerosols, classification and properties, concentration and size distribution, Absorption and scattering of radiation, optical phenomena in atmospheric, Modeling for aerosols, Estimations of radiative forcing. Definition of climate long term changes, possible causes of climate change-External and internal, General idea of internal dynamical processes of the atmosphere, climate modeling, Review of various climate models.	**15**

UNIT IV	**Instrumentation and Observational Techniques** Convectional measurements of pressure, temperature, humidity, wind speed and direction, sunshine duration, radiation clouds, upper air pressure, temperature, humidity and wind measurements, Polit balloons, radiosonde, dropsonde, ozonesonde, GPS sonde. Application of radars to study the atmospheric phenomenon, LIDAR, SONAR, RASS (Radio-acoustic sounding system), Observational technique for aerosol.	**15**
Suggested Readings: S. Pettersen: An Introduction to meteorology H. R. Byer: General Meteorology Miller, Thompson and Paterson: Elements of meteorology J. M. Wallau and P. V. Hobbs: Atmospheric Science J. A. Ratchiffe: Physics of upper atmosphere R. B. Stull: An introduction to boundary layer Meteorology D. H. Lenschow: Probing the atmospheric boundary D. H. Lechow: Intruments and Techniques for probing the atmospheric boundary layer A.A. Tsonis: An introduction to atmospheric Thermodynamics H. J. Critchfield: General Climatology G. T. Trewartha: An introduction to climate		
Can be opted by **Bachelor in Science with Physics as major subject**		
Suggested Continuous Evaluation Methods:		
Course Prerequisites **Passed Semester VII with Physics as major**		
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8		

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTERVIIIE L3(5)
Subject: Physics		
Course code	Course Title: **Nano Materials and Applications**	

Course Outcomes:

This course introduces the essence of nano materials, their synthesis, and characterization. On successful completion of the module students should also be able to understand the optical properties and electron transport phenomenon in nanostructures. It also covers few important applications of nano materials used in this technological era.

Credits: 4	Elective
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**	**Min. Passing Marks: 33**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0	

UNIT	TOPIC	No. of Lectures
UNIT I	**Nanoscale Systems** Density of states (1-D,2-D,3-D). Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.	**15**
UNIT II	**Synthesis of Nanostructure Materials** Metals, Metal Oxide, Carbon based nanomaterials CNT, C60, graphene. Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, Chemical vapor deposition (CVD).Sol-Gel. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots. X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy.	**15**
UNIT III	**Optical Properties** Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and	**15**

	excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostrctures and nanostructures.	
UNIT IV	**Electron Transport and Applications of Nanoparticles** Carrier transport in nanostrcutures. Coulomb blockade effect, thermionic emission, tunneling and hopping conductivity. Defects and impurities: Deep level and surface defects. **Applications:** Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron transfer devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots -magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS).	**15**
Suggested Readings: C. P. Poole, Jr. Frank J.Owens, Introduction to Nanotechnology (Wiley IndiaPvt. Ltd.). S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company) K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited). Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge University Press. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).		
Can be opted by **Bachelor in Science with Physics as major subject**		
Suggested Continuous Evaluation Methods:		
Course Prerequisites **Passed Semester VII with Physics as major**		
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8		

MASTER IN PHYSICS			
Programme: **MASTER IN PHYSICS**		YEAR V	SEMESTER IX PAPER I
Subject: Physics			
Course code	Course Title: **Advanced Quantum Mechanics**		
Course Outcomes: The course includes the study of scattering theory, identical particles, relativistic wave equations and quantization of wave fields. The course would describe the nature and behaviour of matter and energy at subatomic level. In particular, theory of scattering gives an understanding collision between a quantum mechanical particle and target. The study of relativistic quantum mechanics enables the students to understand the behaviour of objects moving with speeds comparable to that of light. The knowledge of this field forms the foundation for pursuing research in Quantum Field Theory and High Energy physics.			
Credits: 4			Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**			**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
UNIT	**TOPIC**		**No. of Lectures**
UNIT I	**Free particle Dirac equation** Discrepancies faced by Schrödinger equations, Klein-Gordon equation and its drawbacks, Dirac's equation for a free particle, Dirac matrices, covariant form of Dirac equation, Probability and current densities, Free particle solutions of Dirac equation, Non conservation of Orbital Angular momentum and idea of spin, Interpretation of negative energy and hole theory		**15**
UNIT II	**Dirac particle in Electromagnetic Fields** Dirac equation in electromagnetic fields, Magnetic moment of charged particle, Gauge invariance of Dirac equation in electromagnetic fields, Non- relativistic correspondence of Dirac equation; Pauli equation, Adjoint spinors, Symmetries of Dirac Equation: Parity, Time reversal and Charge Conjugation; Lorentz covariance of Dirac Equation, , Bilinear covariants		**15**
UNIT III	**Identical Particles and Quantum Field Theory** Identical particles, exchange degeneracy, symmetric and anti symmetric functions for many particle system Classical Fields, Schwinger's action principle, Lagrangian and Hamiltonian densities, Field equation, quantum structure of free fields and the particle concept,		**15**

	Quantization relations, Quantization of non relativistic Schrödinger matter field, System of identical bosons and fermions, Commutation and anti-commutation relations, Occupation number representation, creation and annihilation operators.	
UNIT IV	**Quantum Theory of Scattering** Scattering Theory, Scattering cross section, method of partial wave analysis, phase shift, Optical theorem, scattering length, effective range theory; low energy scattering, Resonance, scattering from a square potential well and a rigid sphere, Born approximation, Validity of Born approximation, Born approximation through time dependent perturbation, its application to square well potential.	**15**
Suggested Readings: Davydov: Quantum Theory Messiah : Quantum Mechanics Vols. I& II Rajput B. S.: Advanced Quantum Mechanics Ropman P.: Advanced Quantum Mechanics Trigg: Quantum Mechanics Thankappan V. K.: Quantum Mechanics Sakurai J.J.: Quantum Mechanics		
Can be opted by **Bachelor in Science with Physics as major subject**		
Suggested Continuous Evaluation Methods:		
Course Prerequisites **Passed Semester VIII with Physics as major**		
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8		

MASTER IN PHYSICS		
Programme: **MASTER IN PHYSICS**	YEAR V	SEMESTER IX PAPER II a
Subject: Physics		
Course code	Course Title: **Computational Physics**	

Course Outcomes:

The subject on Computational Physics has been framed to equip the students of M.Sc. Physics with knowledge of roots of equation, interpolation, curve fitting, numerical differentiation, numerical integration, solution of ordinary differential equations and probability.

Credits: 4	Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**	**Min. Passing Marks: 36**

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

UNIT	TOPIC	No. of Lectures
UNIT I	**Roots of Algebraic and Transcendental Equations:** Element of computational techniques: roots of functions, Interpolation, Extrapolation, One point and two-point iterative methods such as bisection method and Newton Raphson methods.	**12**
UNIT II	**Integration and Differential:** Integration by Trapezoidal and Simpson's rule, Solution of first order differential equation using Runge-Kutta methods, Finite difference methods. Data Interpretation and Error analysis: Dimensional analysis, Precision and accuracy, error analysis, Propagation and errors.	**15**
UNIT III	**Least square fitting:** Least square fitting, Linear and nonlinear curve fitting, Chi square test. Random numbers: Introduction to random numbers, Monte Carlo method for random number generation. Probability Theory: Elementary probability theory, Random variables, Binomial, poisson and normal distributions, Central limit theorem.	**15**
UNIT IV	**Materials Modelling through VASP and SIESTA:** Basis Sets: plane waves versus numerical atomic orbitals basis sets, Pseudopotentials: ultrasoft versus norm conserving pseudopotentials. Numerical solutions of Kohn-Sham equations, Diagnolization procedure, SCF cycles and mixing scheme, Smearing: Gaussian, Fermi and Methfessel-Paxton smearing. SIESTA and VASP package to perform: electronic structure calculations, relaxation of atomic positions and unit cell parameters. Structural properties: equilibrium lattice constant, cohesive energy, bulk modulus.	**18**

Suggested Readings:

1. David S. Sholl and Janice A. Steckel, Density Functional Theory: A Practical Introduction (John Wiley and Sons, 2009).
2. Gunn Lee, Computational Materials Science: An Introduction, (CRC Press 2011) 3.

3. C. Kittel, Introduction to Solid State Physics (Wiley India (P) Ltd., New Delhi, India) 2007	

Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester VIII with Physics as major**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS		
Programme: **MASTER IN PHYSICS**	YEAR V	SEMESTER IX PAPER II b
Subject: Physics		
Course code	Course Title: **Plasma Physics**	
Course Outcomes: The course includes Magneto Hydrodynamics, Plasma Propagation and other topics related to plasma. Plasma physicists study plasmas, which are considered a distinct state of matter and occur naturally in stars and interplanetary space .The knowledge acquired by the student can be used in various field of Physics and thus career prospects are bright in the field of research.		
Credits: 4		Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**		**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	**TOPIC**	**No. of Lectures**
UNIT I	**Introduction to Plasma** Elementary concept of plasma: Debye Shielding, Plasma parameters, Drift of guiding center, Gradient drift, Curvature drift, Magnetic mirror, Plasma confinement	**15**
UNIT II	**Magneto-Hydrodynamics and Fluid Plasma** Plasma Oscillation, Fluid equations for a plasma, Continuity equation, Wave Propogation in unmagnetized plasma, Magneto Hydrodynamics , Hydrodynamical description of Plasma: fundamental equation, Concept of convective derivative, hydromagnetic waves, magneto-sonic and Alfven waves.	**15**
UNIT III	**Magneto Plasma** Wave phenomena in Magneto plasma: Polarization, Phase velocity, group velocity, cutoff, resonance for electromagnetic wave propagating parallel and perpendicular to the magnetic field Helicon, Faraday rotation,.	**15**
UNIT IV	**Electromagnetic Wave Propagation in Plasma** Propagation at finite angle and CMA diagram, Propagation through ionosphere and magnetosphere Derivation of moment Equation from Boltzmann Equation, Momentum balance equation, Equations of state, Two-fluid equations, Plasma resistivity	**15**
Suggested Readings: Jackson: Classical Electrodynamics; Wiley Estern, New Delhi		

Bittencourt: Plasma Physics Chen: Plasma Physics Robert J Goldston and Paul H. Rutherford: Introduction to Plasma Physics	
Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester VIII with Physics as major**	
Suggested Equivalent Online Courses: 4. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 5. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 6. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS		
Programme: **MASTER IN PHYSICS**	YEAR V	SEMESTER IX PAPER III a (Specialization paper)
Subject: Physics		
Course code	Course Title: **Advanced Electronics- I**	
Course Outcomes: This course helps the students to gain basic ideas of the construction and working of electronic devices and circuits . The course includes the study of IC technology, Operational amplifier as linear Analog systems and non-linear analog systems. The course is of much practical purpose for the students to learn basics of integrated circuit technology which has wide applications in computing, process control, signal processing, communication systems, digital instruments etc.		
Credits: 4		Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**		**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		

UNIT	TOPIC	No. of Lectures
UNIT I	**Transmission Lines:** Types of transmission lines, transmission line as a two conductor system, transit time effect, calculation of line parameters, voltage and current relation on radio frequency transmission line, propagation constant and its physical significance, line distortion and attenuation, characteristic impedance, reflection coefficient, loss less, distortion less and low loss transmission lines, line termination by (i) zero load or short circuit line, (ii) infinite impedance, (iii) some resistance, (iv) complex impedance, voltage standing wave ratio.	**15**
UNIT II	**Propagation of Radio Waves:** Ground wave, space wave and sky wave propagation (ionosphere & it's different regions, Eccles-Larmor theory, magneto ionic theory, Appleton-Hartree formula, skip distance and maximum usable frequency).	**15**
UNIT III	**Amplitude Modulation & Demodulation and Receiver & Transmitters:** Need for modulation, type of modulation, amplitude modulators (square law diode & collector modulation methods), amplitude demodulators (square law & envelope detectors), DSB-SC system (balanced modulator and synchronous detector), SSB-SC signal (frequency & phase discrimination method of modulation and demodulation), VSB signal (filter & phase discrimination method of modulation), AM receivers (TRF & superheterodyne, AGC), AM transmitter.	**15**
UNIT IV	**Antenna :** Radiation, flared transmission line, magnetic vector potential and electric scalar potentials, different electric and magnetic fields generated by Hertz dipole, near and far fields, power radiated by Hertz dipole, radiation pattern, Directivity, gain of the antenna, dipole antenna, HF antenna, Yagi antenna, loop antenna, reflector antennas.	**15**

Suggested Readings:

Antennas and Wave Propagation', J.D. Kraus, R.J. Marhefka and A.S. Khan, TMH

'Communication Systems: Analog & Digital', R.P. Singh and S.D. Sapre, TMH

Antenna & Wave Propagation', K.D. Prasad, Satya Prakashan, New Delhi.

Mcgraw Hill

Millman and Halkias: Electronic Fundamentals & Applications, Tata Mcgraw Hill

Millman and Halkias: Integrated Electronics

K.R. Botkar: IntegratedCircuits, Khanna Publishers G.K.

Mithal and Ravi Mittal: Electronic Devices & Circuits, Khanna Publishers

Roychaudhary and Jain: Operational Amplifier & Linear Integrated Circuits

V.K. Mehta: Electronics for Scientists & Engineers Robert J Goldston and Paul H. Rutherford: Introduction to Plasma Physics

Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester VIII with Physics as major**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS		
Programme: **MASTER IN PHYSICS**	YEAR V	SEMESTER IX PAPER III b (specialization paper
Subject: Physics		
Course code	Course Title: **Astrophysics –I**	

Course Outcomes:

The course would be important to understand the spherical astronomy, distance measurement in astrophysics, and physics of solar system and extra solar planets. The course provides an opportunity to understand the optics of the different astronomical instruments such as: telescopes, CCD camera etc. It has wide spared in use of R& D sector.

Credits: 4	Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**	**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0	

UNIT	**TOPIC**	**No. of Lectures**
UNIT I	Spherical Astronomy Celestial sphere, Celestial coordinate system (equatorial and alt-azimuth): altitude and azimuth, right ascension and declination, hour angle, sidereal time, mean solar time, summer and winter solstice, seasons. Distance measurements: AU, parsec, standard candles, distance measurement by geometric means (parallax, distances to open clusters).	**15**
UNIT II	Solar System Idea of solar system, Study of planets and their satellites, Earth-Moon system, tidal forces, asteroids, meteors, comets and their origin, composition and dynamical evolution, extra solar planets and their detection.	**15**
UNIT III	Telescopes: Basic Optics, Types of telescopes. Telescope mounting systems. Optical telescopes, Infrared, Ultraviolet, X-ray and Gamma-ray telescopes. Schmidt telescopes. Solar telescopes. Design and construction of a simple optical telescopes. Active and adoptive optics in astronomical study. Sky charts and their importance.	**15**
UNIT IV	Classification of detectors, characteristics of detectors. Detectors for optical and infrared wavelength regions. Working of Charge Coupled Device (CCD). sensitivity, noise, quantum efficiency, spectral response, Johnson noise, signal to noise ratio, Application of CCD for stellar imaging, photometry and spectroscopy. Importance of space based astronomy. Observational techniques of astronomical sources from space in	**15**

	infrared, EUV, X-ray and Gamma-ray regions of the electromagnetic spectrum.	
Suggested Readings: Abhyankar K. D.: Astrophysics, Galaxies and Stars Vaidyanth Basu: An Introduction to Astrophysics Motz: Astrophysics K S Krishnaswamy: Astrophysics: A Modern Perspective W. M Smart: Spherical Astronomy Mark A. Garlick: The Story of the Solar System		
Can be opted by **Bachelor in Science with Physics as major subject**		
Suggested Continuous Evaluation Methods:		
Course Prerequisites **Passed Semester VIII with Physics as major**		
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8		

MASTER IN PHYSICS		
Programme: **MASTER IN PHYSICS**	YEAR V	SEMESTER IX PAPER III c
Subject: Physics		
Course code	Course Title: **High Energy Physics- I**	
Course Outcomes: Students would be able understand the complex properties and behaviour of high energy particles at the microscopic level. This course would encourage students to peruse higher study and research in particle and high energy Physics.		
Credits: 4		Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**		**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		

UNIT	TOPIC	No. of Lectures
UNIT I	Quantization of Scalar Fields Lagrangian Formulation, Hamiltonian and momentum densities, Neutral and Charged scalar fields and their quantization, Momentum representation and frequency splitting, Identification of various particle operators, Charge operator, Algebra of field operators, Invariant delta function and its representations, Covariant commutation relations and their properties.	**15**
UNIT II	Quantization of Spinor Field Lagrangian formulation for Spinor field, Hamiltonian and momentum densities, Quantization of Spinor Field, Momentum representation and frequency splitting, Identification of various particle operators, Charge operator for Spinor field, Algebra of Spinor field operators, Covariant form of anti-commutation relations.	**15**
UNIT III	Quantization of Electromagnetic Field Classical electromagnetic field theory and its gauge formulation, Covariant Lagrangian formulation for EM field, Quantization of EM field, Momentum representation and frequency splitting,	**15**
UNIT IV	Identification of various particle operators, Concept of longitudinal, temporal and transverse photons, Covariant commutation relations for EM potential operators, Problems with temporal photons and Lorentz condition, Resolution through Gupta- Bleular formulation	**15**

Suggested Readings:

L. Ryder: Quantum Field Theory

B. K. Agarwal: Quantum Mechanics and Field Theory

F Mandel and Shaw: Quantum Field Theory P. Roman: Quantum Field Theory A. Das: Quantum Field theory M. E. Peskin, D.V. Schroeder: An Introduction to Quantum FieldTheory B.S.Rajput : Advanced Quantum mechanics	
Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester VIII with Physics as major**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS		
Programme: **MASTER IN PHYSICS**	YEAR V	SEMESTER IX PAPER III d
Subject: Physics		
Course code	Course Title: **Spectroscopy-I**	
Course Outcomes: In this course the students would study the various types of lasers, Laser spectroscopy and their applications in science and technology. Knowledge acquired by the course will be of much use for various industries and R&D sector .		
Credits: 4		Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**		**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	**TOPIC**	**No. of Lectures**
UNIT I	**Rotational Spectra:** rotational energy level populations, linear, symmetric, spherical and asymmetric top molecules, rotational selection rules for linear molecules, Stark effect in molecular rotation spectra, Molecular rotation-nuclear spin coupling, Positive and negative character of the wave functions of linear molecules, Symmetric-antisymmetric character and statistical weight of homo-nuclear linear molecule.	**15**
UNIT II	**Vibrational Spectra**: Vibration spectra of polyatomic molecule, coupling of rotation and vibration, perpendicular and parallel bands, Normal modes of vibration and their analysis in Cartesian coordinates, normal coordinates and their internal coordinates, calculation of vibrational frequencies and force field of H_2O and CO_2 molecules, anharmonicity, degenerate and non-degenerate vibrations, inversion doubling, Quantized Vibrational motion of polyatomic molecules.	**15**
UNIT III	**Electronic Spectra**: Spectroscopy of Diatomic and Polyatomic Molecules: Coupling of Electronic and Rotational motion in Diatomic Molecules and Rotational structure of 1π - 1Σ and 1Σ - 1Σ transitions. Vibronic interaction and Herzberg Teller theory for absorption spectrum of benzene vapour.	**15**
UNIT IV	Single vibronic level spectroscopy and lifetime of vibronic levels in benzene, Quantum yield, Kasha Rule and the concept of nonradiative transtions in molecules, Jablanski diagram and qualitative treatment of small molecule and large molecule limit for nonradiative transitions.	**15**

Suggested Readings: C.N. Banwell: Fundamentals of Molecular Spectroscopy Walker and Stranghen: Spectroscopy Vol. I, II, & III Herzberg: Spectra of diatomic molecules Jeanne L. Mchale: Molecular Spectroscopy P.F. Bemath: Spectra of atoms and molecules J.M Holias: Modern Spectroscopy K. Thyagrajan and A.K. Ghatak: Lasers: Theory and applications A Yariv: Quantum Electronics	
Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester VIII with Physics as major**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS		
Programme:**MASTER IN PHYSICS**	YEAR V	SEMESTER IX PAPER IIIe
Subject:Physics		
Course code	CourseTitle:-**Condensed Matter Physics-I**	
Course Outcomes: This course develops the basic understanding regarding the principles and concepts of condensed matter physics. The course expose student to the domain of the crystal defect and different types of magnetism. This course will also widen the knowledge behind energy band theory.The present course also enables the concept of dielectrics among the students.		
Credits:4		CoreCompulsory
Max.Marks:100 **ExternalExam:75** **Internalassessment:25**		**Min. PassingMarks:36**
TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):4-0-0		

UNIT	TOPIC	No. of Lectures
UNIT I	**Electronic Properties of Solids:** Electrons in periodic potential, Kronig-Penny model for band theory, brillouin zone, Effective mass, Physical interpretation of effective mass, Distinction between metals, Semiconductors and insulators, Density of state function, Density of electrons in conduction band, Density of holes in valence bands, Donor and acceptor impurities in n-type and p-type semiconductors, Metal-Semiconductor junctions.	**16**
UNIT II	**Dielectric and electrical properties of insulators:** Macroscopic description of dielectric constants, static, electronic and ionic polarizability of molecules, orientational polarization, Internal Lorentz field static dielectric constant, Complex dielectric constant, Dielectric loss and relaxation time, Optical absorption.	**14**
UNIT III	**Magnetism:** Dia, Para and ferromagnetism, Langvin's theory of paramagnetism, Ferromagnetism, Quantum theory of dia and para magnetism, Weiss molecular theory, Ferromagnetic domains, Anti-ferromagnetism, Neel's theory, Two sub-lattice model, ferrites.	**15**
UNIT IV	**Defects in crystals**: Point defect, Impurities, Vacancies, Frenkel defects, Schottky defects, Intrinsic vacancies, Concentration of Schottky defects, Concentration of frankel defects, extrinsicvacancies, Diffusion, Colour centres, F-Centre, V-Centre, dislocation, Line defects, edge dislocation, screw dislocation, Burger vector.	**15**

SuggestedReadings:

1. Kittel C., Introduction to Solid State Physics, Willey Publication, 2008.
2. Ziman J.M, Principles of theory of solids, Cambridge University Press, 2013.
3. Callaway J., Quantum theory of solids, Elsevier, 1976.
4. Dekker A. J., Solid State Physics, Prentice Hall, 1962.
5. Animalu A.O. E, Intermediate Quantum theory of crystalline solids, Prentice-Hall, 1977.

6. Ashcroft N. W. and Mermin N. D., Solid State Physics, Holt, Rinehart and Winston, 1976.
7. Saxena A. K.,Solid State Physics, Laxmi Publication, 2017.

Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester VIII with Physics as major**	
Suggested Equivalent Online Courses: 4. MITOpenLearning-MassachusettsInstituteofTechnology,https://openlearning.mit.edu/ 5. NationalProgrammeonTechnologyEnhancedLearning(NPTEL),https://www.youtube.com/user/nptelhrd 6. SwayamPrabha -DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS			
Programme: **MASTER IN PHYSICS**		YEAR V	SEMESTER IX PAPER IV a
Subject: Physics			
Course code	Course Title: **Advanced Electronics- II**		
Course Outcomes: This course helps the students to gain basic ideas of the digital communication, optical communication, memory and optoelectronic devices. The course is of much practical purpose for the students to learn advanced concepts of digital communication systems.			
Credits: 4			Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**			**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
UNIT	**TOPIC**		**No. of Lectures**
UNIT I	**Modulation Techniques:** Angle modulation (PM & FM), relation between PM & FM, FM generation (direct, varactor diode & reactance tube methods), frequency demodulators (slop & balanced slope method), pulse modulation (PAM & PWM) and demodulation, discretization in time and amplitude, concept of quantization, pulse code modulation (PCM), basic idea of digital telemetry and digital signal processing.		**15**
UNIT II	**Microwave production and Microwave Communications:** Microwave frequencies, advantages of microwaves, limitation of conventional electronic devices at UHF, microwave measurements devices and instrumentation, measurement of power, principle of velocity modulation, two cavity klystron, reflex klystron, transferred electron devices (TEDs), Gunn-effect diodes (GaAs diode only): RWH theory, mode of operation. Satellite communication.		**15**
UNIT III	**Fiber Optics:** Evolution of fiber optics, advantages and classification of fibers, acceptance angle, numerical aperture, propagation of light waves in step index and graded index fibers, optical fiber modes and configurations, attenuation in optical fibers, light sources, detectors and their characteristics, optical communication system, optical fiber sensors: intensity modulated and interferometric optical fiber sensors.		**15**
UNIT IV	**Power Supply Regulation:** Load regulation, line regulation and output resistance of a power supply, shunt & series regulators and their short circuit protection, monolithic linear regulators: classification, LM78XX & LM79XX series, regulated dual supplies and adjustable regulators, current boosters and their short circuit protection, unregulated DC to DC converters, switching regulators: buck, boost and buck-boost regulators, Precision rectifier.		**15**

Suggested Readings: 1. 'Electronic Principles'- A.P. Malvino, TMH Publishing Company Limited. 2. 'Microwave Devices and Circuits'- S.Y Liao, PHI Private Limited. 3. 'Microwave and Radar Engineering' - M. Kulkarni, Umesh Publications. 4. 'Communication Systems - Analog & Digital', R.P. Singh and S.D. Sapre, TMH 5. 'Fundamentals of Fiber Optics in Telecommunication and Sensor, Ed.- B. Pal, New Age International (P) Limited. 6. 'Optical Fiber Communications, Principles and Practice', J.M. Senior, Pearson Education 7. 'Optical Fiber Communications', G. Keiser, TMH Publishing Company Limited.	
Can be opted by Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester VIII with Physics as major	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS			
Programme: **MASTER IN PHYSICS**		YEAR V	SEMESTER IX PAPER IV b
Subject: Physics			
Course code	Course Title: **Astrophysics –II**		
Course Outcomes: The Course will provide the deeper understanding of the radiative transfer and the interaction of radiation with matter. It would be important to understand the physics of the death of stars. This study is crucial for the deeper knowledge of the neutron stars, white dwarfs and black holes. Their study provides the insight for the gravitational waves.			
Credits: 4			Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**			**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
UNIT	**TOPIC**		**No. of Lectures**
UNIT I	Radiation transfer: Definitions of specific intensity, mean intensity, flux and energy density; Equation of radiation transfer; solutions in some specific cases, optical depth; Thermal emission; Blackbody spectrum and its characteristics; Kirchoff's law; Einstein coefficients.		**15**
UNIT II	Interior Properties of Stars Hydrostatic equilibrium, Virial theorem, Polytrophic indices, Lane – Emden equation LTE, Radiative equilibrium, stability condition of convective and radiative equilibrium, Continuous spectra of stars, Stellar opacity, limb darkening, line blanketing, theory of Fraunhofer lines, curve of growth and line broadening.		**15**
UNIT III	Elementary theory of white dwarfs, Chandrashekhar's limit for white dwarf stars, neutron stars their birth and properties, Pulsars, black holes, low medium mass star and high mass stars, death of high mass stars, supernova remnants..		**15**
UNIT IV	AGNs and Quasi-stellar Objects Theory of AGNs, Syferts, quasars and their energy generation and redshift anomaly. Different AGN models, radio lobes and jets, Gamma ray bursts.		**15**
Suggested Readings: Abhyankar K.D.: Astrophysics, Galaxies and Stars Vaidyanth Basu: An Introduction to Astrophysics motz: Astrophysics A. R. Choudhuri : Astrophysics for Physicists			

B. D. Abhyankar: An Introduction to Astrophysics T. Padmanabhan : Astrophysical Processes	
Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester VIII with Physics as major**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS			
Programme: **MASTER IN PHYSICS**		YEAR V	SEMESTER IX PAPER IV c
Subject: Physics			
Course code	Course Title: **High Energy Physics-II**		
Course Outcomes: The course would provide the knowledge of basic building blocks of matter and its complex properties.The students will also be able to know the complicated theory of Higgs mechanism which led to the detection of God particle in LHC experiment in the year 2012.It would open doors for the students who want to work in the field of HEP.			
Credits: 4			Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**			**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
UNIT	**TOPIC**		**No. of Lectures**
UNIT I	Lie Groups and Lie Algebra Symmetries, Groups and conservation laws, Lie groups and their generator, representation of the groups, Lie Algebra, Different dimensions and parameter groups-their generators and algebra, Simple and semi-simple Lie Algebra, Standard form of Lie Algebras, Root diagrams for groups of different rank.		**15**
UNIT II	Quark Model Fermi Yang model, Sakata model, Necessity of Quark model, Shortcomings of Eight fold way, Gell - Mann Zweig model, Quark-Lepton symmetry and structure of Hadrons, Need of charm quantum number and charmed quark , Elementary idea of charm, bottom and top quarks, Baryon magnetic moments in quark model, Experimental status of Quarks.		**15**
UNIT III	Gauge Field Theories Concept of gauge fields and gauge connections, Principle of gauge invariance, Global and local Abelian gauge invariance, U(1) gauge invariance of QED.		**15**
UNIT IV	Yang- Mills gauge field, Non-Abelian gauge field theory (SU(2) case), Concept of spontaneous symmetry breaking and Goldstone Bosons, Higgs Mechanism with physical examples and mass generation for gauge fields		**15**
Suggested Readings: .E. Close: Quarks and Patrons D.C. Cheng and O Neil: Elementary Particle Physics P.Cheng and G. LF Li: Gauge Field Theory I. J. Aitchison and A. J. Hey: Gauge theories in Particle Physics H. Georgi : Lie Algebras in particle Physics			

D. B. Lichtenberg : Unitary Symmetry and Elementary Particles, Academic Press, 1978	
Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester VIII with Physics as major**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS			
Programme: **MASTER IN PHYSICS**		YEAR V	SEMESTER IX PAPER IV d
Subject: Physics			
Course code	Course Title: **Spectroscopy -II**		
Course Outcomes: In this course the students would study the various types of lasers, Laser spectroscopy and their applications in science and technology. Knowledge acquired by the course will be of much use for various industries and R&D sector .			
Credits: 4			Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**			**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
UNIT	**TOPIC**		**No. of Lectures**
UNIT I	**Radiation and Matter** Interaction of radiation with matter, Einstein quantum theory of radiation, Einstein's coefficients, Momentum Transfer, Lifetime, Theory of optical frequencies, Coherence Spatial and temporal and Monochromaticity, kinetics of optical absorption, line width, line broadening mechanisms.		**15**
UNIT II	**Basic Elements of Lasers** Spontaneous emission, Stimulated emission, Possibility of amplification, laser pumping, Population Inversion, Three and four level scheme, Threshold condition, rate equations, Active resonators & laser modes, gain saturation.		**15**
UNIT III	**Type of Lasers** Different types of lasers, gas lasers, He-Ne laser, N_2 & CO_2 lasers dye lasers, solid state lasers, Nd-YAG, semiconductor lasers. Tunability of lasers		**15**
UNIT IV	**Applications of Lasers** Basic application of laser spectroscopy, laser cooling and trapping of atoms etc.		**15**
Suggested Readings: Banwell: Fundamentals of Molecular SpectroscopyWalker and Stranghen: Spectroscopy Vol. I, II, & IIIHerzberg: Spectra of diatomic molecules Jeanne L Mchale: Molecular Spectroscopy .F. Bemath: Spectra of atoms and molecules M Holias: Modern Spectroscopy K. Thyagrajan and A.K. Ghatak: Lasers: Theory and applications			

A Yariv: Quantum Electronics	
Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester VIII with Physics as major**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS		
Programme:**MASTER IN PHYSICS**	YEARV	SEMESTER IX PAPER IVe
Subject:Physics		
Course code	CourseTitle: **Condensed Matter Physics -II**	

CourseOutcomes:

The present syllabus provides knowledge about the basic concepts, principles and the variou properties exhibited by condensed matter, especially solids to the students.The course widens th domain knowledge of ferroelectrics.The course also develops the basics knowledge c superconductors and their properties.This course also deals with the topics like transport propertie and magnetic resonance, and imparts knowledge to the students.

Credits:4	Core Compulsory
Max.Marks:100 **ExternalExam:75** **Internalassessment:25**	**Min.PassingMarks: 36**
TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):4-0-0	

UNIT	TOPIC	No. ofLectures
UNIT I	**Nearly free electron model**: One dimensional free electron case, Nearly free electron case, energy bands in one dimension, tight binding approximation, energy surfaces, Wigner Seitz cellular method, Orthogonalized plane wave (OPW) method, Pseudo potential method, Limitations of band theory (Mott Transition)	**15**
UNIT II	**Ferroelectrics Materials:** Structural phase transition, ferroelectric crystals, classification of ferroelectric crystals, displacive transition, soft optical phonons, landau theory of phase transition, Second and first order transition, optical absorption, transmission and reflection. antiferroelectricity, ferroelectric domains.	**15**
UNIT III	**Superconductivity:** Experimental Survey, Occurrence of super conductivity, destruction of superconductivity by magnetic field and temperature, Meissner effects, Type-I and Type-II superconductors, Isotope effect, Thermodynamics of Superconducting transition, London Equations, Coherence length, BCS Theory, Cooper pairs, Josephson superconductor tunneling, AC & DC Josephson effect, High temperature superconductors, critical fields and critical currents**.**	**15**
UNIT IV	**Transport properties and magnetic resonance:** Sommerfeld theory of electrical conductivity, Boltzmann transport equation, Relaxation time, Experimental determination of Hall coefficient, Residual resistivity, Temperature dependent resistivity, Principle of magnetic resonance, Nuclear magnetic resonance, Electron spin resonannce, Resonance, Flourescence, Theory of Mössbauer effect, Isomer shift, Quadrupole interaction, magnetic hyperfine interaction.	**15**

SuggestedReadings: 1. Lubensky T.C. and, Chaikimand P.M., Principle of condensed matter Physics, Cambridge University Press, 2012. 2. Ryogo K., Solid State Physics, McGraw-Hill, 1969. 3. Srivastava, J. P, Elements of Solid State Physics, Prentice Hall of India, 2006. 4. Otfried M., Introduction to Solid State Physics, Spinger, 1978. 5. Patterson J., and Bernard C., Introduction to Solid State Physics, Springer, 2007. 6. Kittel C., Introduction to solid state Physics, Wiley, 2008. 7. Ashcroft N. and Mermin N., Solid State Physics, Cambridge University Press, 1976. 8. Saxena A. K., Solid State Physics, Laxmi Publication, 2017.	
Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester VIII with Physics as major**	
Suggested Equivalent Online Courses: 7. MITOpenLearning-MassachusettsInstituteofTechnology,https://openlearning.mit.edu/ 8. NationalProgrammeonTechnologyEnhancedLearning(NPTEL),https://www.youtube.com/user/nptelhrd 9. SwayamPrabha -DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS			
Programme: **MASTER IN PHYSICS**		YEAR IV	SEMESTER IX/PAPER V
Subject: Physics			
Course code	Course Title: PRACTICAL		
Course Outcomes: The student will have adequate knowledge to perform the experiments of different fields of physics with clear understanding of the theory behind the experiment. Student will know about various electronics experiments and some advanced experiments in Physics			
Credits: 4			Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**			**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-4			
UNIT	**List of Experiments**		**No. of Lectures**
	1. Verification of Richardson's law. 2. Study of ESR spectra of a given sample. 3. Hall Effect 4. RCS Spectrometer 5. Gamma ray spectrometer 6. Radio Receiver 7. e by Millikan's oil drop method. 8. Temperature dependence of diode characteristics. 9. Elastic constants of a cubic crystal by ultrasonic waves. 10. Study of Multivibrators. 11. Study of transistor amplifier cum feedback amplifiers. 12. Study of absorption of $KMnO_4$ by Spectrophotometer 13. Study of different FETs and MOSFETs. 14. Study of Thermo luminance. 15. Study of VTVM.		**60**
Can be opted by **Bachelor in Science with Physics as major subject**			
Suggested Continuous Evaluation Methods:			
Course Prerequisites **Bachelor in Science with Physics as major subject**			
Suggested Equivalent Online Courses: 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	

MASTER IN PHYSICS		
Programme: **MASTER IN PHYSICS**	YEAR V	SEMESTER X PAPER I
Subject: Physics		
Course code	Course Title: **Nuclear Physics**	
Course Outcomes: In this course students would know about the general properties of nuclei, nuclear forces and detectors, radioactive decay and nuclear reactions.The course builds a foundation for the students to carry out research in the field of nuclear physics, high energy physics, nuclear astrophysics, nuclear reactions and applied nuclear physics.		
Credits: 4		Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**		**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		

UNIT	**TOPIC**	**No. of Lectures**
UNIT I	Nuclear Properties and Nuclear Models Concepts of Atomic Nuclear-Size, Shape, charge distribution, spin & parity, magnetic moment; electric quadrupole moment; binding energy; semi-empirical mass formula, mirror nuclei, Liquid drop model, Experimental evidence for shell effects, Shell model, Magic numbers, Spin orbit coupling, Single particle shell model-its validity and limitations; collective model.	**15**
UNIT II	Nuclear Forces and Nuclear Interactions Theory of Deuteron and nuclear level properties, nucleon - nucleon interactions, low & highenergy nucleon-nucleon scattering, Yukawa's Meson theory of nuclear forces, Spin dependence and charge independence of nuclear forces.	**15**
UNIT III	Nuclear Reactions Kinds of nuclear reactions; Conservation laws; Nuclear reaction Kinematics; charge particle reaction spectroscopy; neutron spectroscopy; nuclear cross-section; compound nucleus; Nuclear transmutations, continuum theory of nuclear reaction, Nuclear fission, Chain reactions, Nuclear fusion, Thermonuclear reactions.	**15**
UNIT IV	Nuclear Decays Basic understanding of and - decay, Fermi theory of beta decay, selection rules in -decay, Neutrino hypothesis, Parity violation in beta decay, K capture and internal conversion.	**15**

Suggested Readings: E. Burcham: Nuclear Physics Ervin Kapalan: Nuclear Physics Roy & Nigam: Nuclear Physics S. N. Ghoshal: Atomic and Nuclear Physics A. Enge: Nuclear Physics .D. Evans: Nuclear Physics E. Segre: Nuclei and Particles H.M. Agrawal: Nuclear Physics, PHI Learning	
Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester IX with Physics as major**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS		
Programme: **MASTER IN PHYSICS**	YEAR V	SEMESTER X PAPER II
Subject: Physics		
Course code	Course Title: **Digital Electronics and Computer Architecture**	
Course Outcomes: The course enables student to get knowledge about Digital Electronics and Computer Architecture. The course includes Fundamentals of Digital Circuit, Computer Organization and Architecture , Instruction formats & Microprocessor, Data Communication, Computer and Communications.The course helps student to work for the development of technology and also the for the industry and various Government organizations.		
Credits: 4		Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**		**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		

UNIT	TOPIC	No. of Lectures
UNIT I	Digital Circuit & Microprocessor Elementary idea of combinational and sequential circuits, Overview of Microcomputer organization and operation, Microprocessor evolution and types, Fundamental knowledge of Microprocessor (8085/8086), Architecture and its operation, Basic idea of logic devices for interfacing 8085/8086.	**15**
UNIT II	Computer Organization and Architecture Central Processing Unit, Computer organization, Instruction formats (e.g. Three address, Two address etc), addressing modes, Timing diagram, Interconnection of different units, I/0 to processor and processor to memory communication, Interrupt structures, Multiprogramming, processor features RISC, CISC, cache memory, real and virtual memory.	**15**
UNIT III	Data Communication Computer and Communications, Need for communication networks, Internet and World Wide Web, communication protocols, Local Area Networks, Interconnecting networks, Future of Network Technology.	**15**
UNIT IV	Computer Network Characteristics of communication channels, Allocation of Channels, Physical Communication media, Public Switched Telephone Network, Cellular Communication Path, ATM networks	**15**
Suggested Readings: Morris Mano : Computer system Architecture, (PHI) (Eastern Economy Edition)		

V. Rajaraman: Fundamentals of computers, (Prentice Hall ofIndia) Morries Mano: Computer system architecture, (Estern Economy Edition) B. Ram: Computer fundamental-architecture and organization (New Age International Publishers) Tenan Bomm: Computer Network Ramesh Gaonkar: Microprocessor, Architecture, programming and application with the 8085 Hafizer Rehaman: Microprocessor programming and Interfacing Intel 8085 and 8086	
Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester IXwith Physics as major**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS			
Programme: **MASTER IN PHYSICS**		YEAR V	SEMESTER X PAPER III A
Subject: Physics			
Course code	Course Title: **Advanced Electronics-III**		
Course Outcomes: This course helps the students to gain advanced concepts of power supply regulation, microwave production and microwave generation which has wide applications in modern industry and Research.			
Credits: 4			Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**			**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
UNIT	**TOPIC**		**No. of Lectures**
UNIT I	**Integrated Circuit Technology:** Classification of IC's, crystal growth and wafer preparation, monolithic IC processes: oxidation, photo and fine line lithography, wet and dry etching, diffusion and ion implantation, epitaxial growth and metallization, fabrication of IC components: resistors, capacitors, diodes and bipolar transistor.		**15**
UNIT II	**Operational Amplifier (OA):** Differential amplifier and its configurations, DC and AC analysis of differential amplifier, CMRR, operational amplifier, circuit type of OA 741, effects of offset, virtual ground, virtual short, inverting and non-inverting amplifier.		**15**
UNIT III	**Linear Analog systems: S**umming and difference amplifier, voltage follower, OA as log and antilog amplifiers, multiplier, voltage to current converter, current to voltage converter, integrator and differentiator.		**15**
UNIT IV	**Non-Linear Analog Systems:** Comparator, sample and hold circuit, IC 555 timer, waveform generator, instrumentation amplifier, precision rectifier, active filters (first order only), Phase Locked Loop.		**15**
Suggested Readings: 1. 'Operational Amplifiers and Linear Integrated Circuits'- R.F. Coughlin and F.F. Driscoll, PHI Private Limited. 2. 'Op-Amps and Linear Integrated Circuits'- R.A. Gayakwad, PHI Private Limited. 3. 'Integrated Circuits' - K.R. Botkar, Khanna Publishers. 4. 'Fundamentals of Semiconductor Fabrication' - G.S. May and S.M. Sze, John Wiley & Sons, Inc.			

Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester IX with Physics as major**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS		
Programme: **MASTER IN PHYSICS**	YEAR V	SEMESTER X PAPER III B
Subject: Physics		
Course code	Course Title: **Astrophysics-III**	
Course Outcomes: This course provides the basic physical mechanisms about the solar activities, which will help to probe the Sun- Earth connection. This study provides the knowledge of Astroseismology, classification of stars and the distribution in Galaxies.		
Credits: 4		Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**		**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		

UNIT	TOPIC	No. of Lectures
UNIT I	Sun as a star : Solar spectrum, effective temperature, luminosity, photospheric absorption lines, limb darkening; energy source: Kelvin time scale, nuclear fusion; energy transport in the sun, Thomson scattering, mean free path, photon diffusion inside the Sun; photosphere, chromosphere, transition region, corona.	**15**
UNIT II	Quiet and Active Sun, Sunspots, their formation and magnetic field, Solar flares, Solar filaments/prominences, Coronal mass ejections (CMEs), Solar wind, Different type of solar eruptions models, Coronal heating, Origin of solar cycle.	**15**
UNIT III	General idea of Heliosesmology, Astroseismology, Description about p-mode and g-mode oscillations, Introduction to variable stars and their locations in H-R diagram. Classifications, Cephieds variables (classic Cephieds and W Virginis stars), RR Lyrae stars, Mira variables, Eruptive variables, Flare stars, Nebular variables, Supernovae, roAP stars	**15**
UNIT IV	The Milky way and Other Galaxies Distributions of stars in the Milky way, Morphology, Kinematics, Interstellar medium, Galactic center. External galaxies, Types of galaxies: spirals, ellipticals and irregulars, Hubble classification for galaxies, 21cm line, rotation cure, dark matter.	**15**

Suggested Readings:

Stix: The Sun: An Introduction

K. D. Abhyankar : Astrophysics: Stars and Galaxies

T. Padmanabhan : Galaxies and Cosmology Motz : Astrophysics	
Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester IX with Physics as major**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS		
Programme: **MASTER IN PHYSICS**	YEAR V	SEMESTER X PAPER III C
Subject: Physics		
Course code	Course Title: **Hight Energy Physics-III**	

Course Outcomes:

The course would provide the knowledge of advanced concepts of HEP. The students will be able to know the complicated theory of Relativistic propagators, S matrix expansion ans S matrix formulation of QED. It would open doors for the students who want to work in the field of HEP.

Credits: 4	Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**	**Min. Passing Marks: 36**

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

UNIT	TOPIC	No. of Lectures
UNIT I	Relativistic Propagators Relativistic propagators using quantized formulation of free fields, Properties of quantized scalar fields(Real and complex cases), Algebra of field operators, covariant form of the field operators algebras, (Covariant commutation relations), Meson propagator and its characteristics, Properties of quantized spinor fields, Algebras of spinor field operator, Covariant form of anti-commutation relations, Fermion propagator and its characteristics, properties of quantized EM field, Covariant commutation relations of EM field operators, Photon propagator and its characteristics, EM interaction in terms of radiation field and instantaneous coulomb fields.	**15**
UNIT II	Operator Products, Feynman Propagators and S-matrix Expansion Various type of operator products (Normal, Dyson products and Chronological T-products), Wick's theorem, Feynman propagators and its physical interpretation, Interacting fields, S-Matrix formulation as a perturbative series solution of collision processes, Dyson expansion of S-matrix.	**15**
UNIT III	S-matrix Formulation of QED Interaction Hamiltonian in QED, Reduction of S-matrix for the case of QED, Representation and description of various first and second order processes in QED using S-matrix expansion.	**15**
UNIT IV	Compton scattering, Moller scattering, Bhabha scattering, Electron self energy, Photon self energy, vacuum configuration in QED, Feynman diagrams and Feynman Rules in QED.	**15**

Suggested Readings: Ryder: Quantum Field Theory B.K. Agarwal: Quantum Mechanics and Field Theory F Mandel and G. Shaw: Quantum Field Theory Roman: Quantum Field Theory A. Das: Quantum Field theory M. E. Peskin, D.V. Schroeder: An Introduction to Quantum Field Theory		
Can be opted by **Bachelor in Science with Physics as major subject**		
Suggested Continuous Evaluation Methods:		
Course Prerequisites **Passed Semester IX with Physics as major**		
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8		

MASTER IN PHYSICS		
Programme: **MASTER IN PHYSICS**	YEAR V	SEMESTER X PAPER III D
Subject: Physics		
Course code	Course Title: **Spectroscopy-III**	
Course Outcomes: In this course the students would study the various types of lasers, Laser spectroscopy and their applications in science and technology. Knowledge acquired by the course will be of much use for various industries and R&D sector .		
Credits: 4		Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**		**Min. Passing Marks: 33**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		

UNIT	TOPIC	No. of Lectures
UNIT I	Molecular Symmetries and Group Theory Symmetry Properties of molecule: symmetry element, symmetry operation and point group, character table, Group theory: representation of a group, reducible and irreducible representations, LCAO coefficient of a polyatomic molecule, Huckel approximation, overlap and resonance integrals, Wheal's approximation.	**15**
UNIT II	Mechanism of Fluorescence Emission and decay mechanism, radiative & nonradiative processes, Jablonski diagram, Kasha rule, Fluorescence lifetime and quantum yield, stoke shift, Mirror image rule, Oscillator strength, Fluorescence polarisation and Anisotropy, Time scale of molecular processes in solution .	**15**
UNIT III	Instrumentation for Fluorescence Spectroscopy Excitation and Emission spectra, An ideal spectrofluorometer Distribution in Excitation & Emission spectra, Light sources, Monochromator,	**15**
UNIT IV	Optical filters, Photomultiplier tubes, Photon counting versus Analog detection of Fluorescence Corrected Fluorescence spectra, Measurement of Fluorescence lifetime	**15**

Suggested Readings:

Barrow G. M: Introduction to Molecular spectroscopy; McgrawHill

Herzberg G: Infrared and Raman Spectra of Polyatomic Molecules;

Von Nostrand Herzberg G: Spectra of Polyatomic Molecules;

on Nostrand J. R. Lackowicz: Principle of Fluorescence

Spectroscopy King G: Molecular Spectroscopy King G.W: Spectroscopy and Molecular Structure	
Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester IX with Physics as major**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS		
Programme:**MASTER IN PHYSICS**	YEARV	SEMESTERX PAPERIIIe
Subject: Physics		
Course code	CourseTitle: **Condensed Matter Physics -III**	
CourseOutcomes: The present syllabus provides knowledge about the basic concepts, principles and the various properties exhibited by condensed matter, especially solids to the students.The course widens the domain knowledge of synthesis of nanomaterials.The course also develops the basics knowledge of carbon nanotubes to the students.		
Credits:4		Core Compulsory
Max.Marks:100 **ExternalExam:75** **Internalassessment:25**		**Min.Passing Marks:36**
TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):4-0-0		

UNIT	TOPIC	No. ofLectures
UNITI	**Nanoscale Systems**: Nano science, Nano technology Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation-Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences..	**15**
UNITII	**Synthesis of Nanomaterials-I** : Physical Methods: Top-down vs. Bottom-up Technique, Nonlithographic Techniques: Plasma Arc Discharge, Sputtering, Electron Beam and Thermal Evaporation, Pulsed Laser Deposition, Molecular Beam Epitaxy. Lithographic Process and its Limitations: Electron beam lithography, Ion beam lithography, Photo lithography, x-ray lithography.	**15**
UNITIII	**Synthesis of Nanomaterials-II:** Chemical Methods: Chemical Vapor Deposition (CVD), Sol-gels techniques, Co-precipitation, Hydrothermal, Spin and Dip coating techniques and Spray pyrolysis, Chemical Etching Techniques, Electroplating, Langmuir Blodgett(L-B) method, microemulsions.	**15**
UNITIV	**Carbon based Nanomaterials:** Introduction to Carbon Clusters, CNTs and synthesis of carbon nanotubes.Growth mechanism, electronic structure of carbon nanotubes, preparation and characterization of fullerenes and graphene.Nanodiamond, Defects and purifications in CNT(Brief).	**15**

SuggestedReadings:

1. Lubensky T.C. and, Chaikimand P.M., Principle of condensed matter Physics, Cambridge University Press, 2012.
2. Ryogo K., Solid State Physics, McGraw-Hill, 1969.
3. Srivastava, J. P, Elements of Solid State Physics, Prentice Hall of India, 2006.
4. Otfried M., Introduction to Solid State Physics, Spinger, 1978.
5. Patterson J., and Bernard C., Introduction to Solid State Physics,

Springer, 2007.
6. Kittel C., Introduction to solid state Physics, Wiley, 2008.
7. Ashcroft N. and Mermin N., Solid State Physics, Cambridge University Press, 1976.
8. Saxena A. K., Solid State Physics, Laxmi Publication, 2017.

Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester VIII with Physics as major**	
Suggested Equivalent Online Courses: 10. MITOpenLearning-MassachusettsInstituteofTechnology,https://openlearning.mit.edu/ 11. NationalProgrammeonTechnologyEnhancedLearning(NPTEL), https://www.youtube.com/user/nptelhrd 12. SwayamPrabha -DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS		
Programme: **MASTER IN PHYSICS**	YEAR V	SEMESTER X PAPER IV A
Subject: Physics		
Course code	Course Title: **Advanced Electronics-IV**	

Course Outcomes:

This course helps the students to gain basic ideas of the construction and working of electronic devices and circuits. The course includes the study of combinational circuits, sequential circuits and analog computation. The course is of much practical purpose for the students to learn basics of digital electronics. The digital electronics has wide applications in computing, process control, signal processing, communication systems, digital instruments etc.

Credits: 4	Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**	**Min. Passing Marks: 36**

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

UNIT	TOPIC	No. of Lectures
UNIT I	**Review of logic devices:** logic gates, tristate switch, Buffer, Decoder, Encoder and D-Flip-flops, RAM, ROM, etc., generic microcomputer, architecture of a microprocessor, 8085 microprocessor architecture.	**15**
UNIT II	**Instructions-I:** 8085 instruction set, data transfer operations, arithmetic operations, logic operations, branch operations, stack and subroutines, restart, conditional call and return instruction, writing assembly language programs, debugging a program.	**15**
UNIT III	**Instructions-II:** 8085 timing processes, opcode fetch, machine cycle, read and write cycle timing, interrupt acknowledge timing, timing diagrams of different instructions, 8085 interrupts, 8085 vectored interrupts, serial I/O lines (SID & SOD).	**15**
UNIT IV	**Interfacing of devices:** memory mapping, I/O mapping, memory interfacing- interfacing of 4K × 8, 8K × 8 and 16K × 8 memory chips, interfacing I/O devices, architecture and programming of 8255 (PPI), 8251 (USART), and idea of other peripherals.	**15**

Suggested Readings:

1. 0000 to 8085, Introduction to microprocessors for engineers and scientists: P.K. Gosh and P.R. Sridhar (PHI)
2. Microprocessor Architecture, programming, and applications with the 8085: Ramesh Gaonkar (Penram)

Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester IX with Physics as major**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS		
Programme: **MASTER IN PHYSICS**	YEAR V	SEMESTER X PAPER IV B
Subject: Physics		
Course code	Course Title: **Astrophysics-IV**	
Course Outcomes: This course will provide the basic properties of stars, birth and the evolution of stars. In addition of this, it provides the deep understanding about the star clusters and their properties, e.g. luminosity and mass function, mass-luminosity relations etc.		
Credits: 4		Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**		**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		

UNIT	TOPIC	No. of Lectures
UNIT I	**Basic Properties of Stars:** Mass, radius, distance, luminosity, temperature, magnitude system, Wien-displacement colour indices, filters, H-R diagram, classification of stellar spectra, luminosity classification, stellar motion, stellar populations	**15**
UNIT II	**Star Formation and Stellar Evolution:** Birth of stars, protostar, Pre- main sequence evolution: Jeans instability, star formation, Hayashi track, Zero age main sequence (ZAMS), Post-main sequence evolution: Core He burning, shell burning, red giant phase, planetary nebulae, white dwarf physics, electron degeneracy pressure, energy generation in stars – gravitational contraction, pp chain, CNO cycle and triple alpha process, stellar life, cycles-Premain sequence, main sequence, giants.	**15**
UNIT III	**Star Cluster and their Properties**: Open clusters, globular clusters and the galaxy itself are examples of 'stellar systems'; crossing time; mean potential and total potential energy in a constant density sphere; equation of motion of N-body stellar system; total momentum, angular momentum and energy as constants of motion, stellar population, population I and II type objects, inter-stellar extension, reddening determination from color color diagram, age and distance determination of star clusters, luminosity function, mass function, mass segregation, mass-luminosity relation.	**15**
UNIT IV	**Cosmological Models:** Universe at large scales – Homogeneity and isotropy – distance ladder – Newtonian cosmology - expansion and redshift - Cosmological Principle - Hubble's law - Robertson-Walker metric - Observable quantities – luminosity and angular diameter distances - Horizon distance- Dynamics of Friedman- Robertson-Walker models: Friedmann equations.	**15**

Suggested Readings: Abhyankar K. D.: Astrophysics, Galaxies and Stars Vaidyanth Basu: An Introduction to Astrophysics Motz: Astrophysics T. Padmanabhan: Stars and Stellar Systems L Kutner: Astronomy: A Physical Perspective	
Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester IX with Physics as major**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS			
Programme: **MASTER IN PHYSICS**		YEAR V	SEMESTER X PAPER IV C
Subject: Physics			
Course code	Course Title: **High Energy Physics-IV**		
Course Outcomes: The course would provide the knowledge of some more advanced concepts of HEP. The students will also be able to know the detailed theory of weak interactions, electromagnetic interactions and strong interaction.			
Credits: 4			Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**			**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
UNIT	**TOPIC**		**No. of Lectures**
UNIT I	Theory of Weak Interactions Classification of weak interaction in terms of Leptonic, Semi-leptonic and Non-Leptonic weak Decays, Current-Current Interaction and VA theory, Intermediate Vector Boson (IVB) concept, Conservation of Vector Current (CVC) Hypothesis, Two Component Theory of Neutrino, W and Z bosons as weak gauge bosons.		**15**
UNIT II	Theory of Electromagnetic Interactions Electron Positron Annihilation into Hadrons, Electron- Nucleon Scattering, Rutherford and Mott scattering, Electromagnetic form factors of Hadrons, Structure of nucleons, Elementary Idea of Unification of Fundamental Interactions with reference to standard model of electro weak unification.		**15**
UNIT III	Strong Interactions Paradoxes of Naive Quark Model, Need of color quantum Number for Quarks, Color SU(3) and Gluons, Quantum Chromodynamics, Pion-Nucleon Scattering,		**15**
UNIT IV	Spin Classification of Hadrons and Regge Trajectories, Asymptotic freedom and Perturbative QCD, Experimental indication for quarks and gluons, String model of hadrons and confinement of Quarks.		**15**
Suggested Readings: E Close: Quarks and Patrons I.J. Aitchison and A.J. Hey: Gauge theories in Particle Physics F. Haltzin& A.D. Martin: Quarks and Leptons D.H. Perkins : Introduction of High Energy Physics, Cambridge University Press 2000			

P. Cheng and G. LF Li: Gauge Field Theory ED Commins: Weak Interactions D.C. Cheng and O Neil: Elementary Particle Physics	
Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester IX with Physics as major**	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS		
Programme: **MASTER IN PHYSICS**	YEAR V	SEMESTER X PAPER IV D
Subject: Physics		
Course code	Course Title: **Spectroscopy-IV**	
Course Outcomes: In this course the students would study the various types of lasers, Laser spectroscopy and their applications in science and technology. Knowledge acquired by the course will be of much use for various industries and R&D sector .		
Credits: 4		Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**		**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	**TOPIC**	**No. of Lectures**
UNIT I	Ultrashort Pulses and Dynamics of Laser Processes Production of giant pulse, Q-switching by different types of shutters, giant pulse dynamics, laser amplifiers, mode locking, mode pulling, ultra shot pulses, hole burning, holography	**15**
UNIT II	Non-Linear Optics Harmonic generation, phase matching, second harmonic generation, third harmonic generation, optical mixing, parametric generation of light, self focusing of light.	**15**
UNIT III	Multi Photon Processes Multi quantum photoelectric effect, two photon processes, frequency up-conversion.	**15**
UNIT IV	Stimulated Raman effect, coherent stokes & anti-stokes Raman scattering, photo acoustic spectroscopy	**15**
Suggested Readings: D. Levenson: Introduction to non-linear laser spectroscopy B. Laud: Laser and non-linear optics Svelto: Lasers Demtroder: Laser Spectroscopy		
Can be opted by **Bachelor in Science with Physics as major subject**		
Suggested Continuous Evaluation Methods:		
Course Prerequisites **Passed Semester IX with Physics as major**		
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology,		

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

MASTER IN PHYSICS			
Programme:**MASTER IN PHYSICS**		YEARV	SEMESTERX PAPERIVe
Subject:Physics			
Course code	CourseTitle: **Condensed Matter Physics -IV**		
CourseOutcomes: This course develops the fundamental understanding of of various characterization techniques. The course covers the in details X-ray diffraction, SEM, TEM etc.			
Credits:4			Core Compulsory
Max.Marks:100 **ExternalExam:75** **Internalassessment:25**			**Min. PassingMarks:36**
TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):4-0-0			
UNIT	**TOPIC**		**No. of Lectures**
UNITI	**Structural Characterization and Analysis:** Introduction to materials characterization, Bragg's Law, Generation and detection of X-rays, X-ray diffraction methods (XRD), Determination of crystal structure, Lattice Parameter, Crystallite Size, Lattice Strain measurements, Williamson Hall Plot; Electron diffraction.		**15**
UNITII	**Electron Microscopy and Surface Analysis:** Interaction of electrons with solids, Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Scanning transmission electron microscopy (STEM), Scanning Probe Microscope (SPM): Atomic force microscopy (AFM), scanning tunneling microscopy (STM).		**15**
UNITIII	**Optical and Thermal Characterization:** Optical Microscopy, UV/Visible spectroscopy, Fourier Transform Infrared spectroscopy (FTIR), Atomic absorption spectroscopy (AAS), Raman spectroscopy. Thermo gravimetric analysis (TGA), Differential thermal analysis (DTA), DifferentialScanning Calorimetry (DSC).		**15**
UNITIV	**Magnetic Characterization:** Spectroscopy Techniques: Basic of nuclear magnetic resonance (NMR) and electron spin resonance (ESR) spectroscopy, Magnetic Measurements: Vibrating Sample Magnetometer (VSM), Superconducting Quantum Interference Device (SQUID), Magnetic Force Microscopy, Mössbauer Spectroscopy.		**15**
SuggestedReadings **1.**Poole C.P., Owens Jr. Frank J., Introduction to Nanotechnology, Wiley India Pvt. Ltd. **2.** Kulkarni S.K., Nanotechnology: Principles & Practices, Capital Publishing Company. **3.** Chattopadhyay K.K. and Banerjee A. N., Introduction to Nanoscience and Technology, PHI Learning Private Limited. **4.** Booker R., Boysen E., Nanotechnology, John Wiley and Sons. **5.** Hosokawa M., Nogi K., Naita M., Yokoyama T., Nanoparticle Technology Handbook, Elsevier, 2007. **6.** Bhushan B., Springer Handbook of Nanotechnology, Springer-Verlag, Berlin, 2004.			

Can be opted by **Bachelor in Science with Physics as major subject**	
Suggested Continuous Evaluation Methods:	
Course Prerequisites **Passed Semester VIII with Physics as major**	
Suggested Equivalent Online Courses: 13. MITOpenLearning-MassachusettsInstituteofTechnology,https://openlearning.mit.edu/ 14. NationalProgrammeonTechnologyEnhancedLearning(NPTEL), https://www.youtube.com/user/nptelhrd 15. SwayamPrabha -DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS			
Programme: **MASTER IN PHYSICS**		YEAR V	SEMESTER X PRACTICAL
Subject: Physics			
Course code	Course Title: PRACTICAL		
Course Outcomes: The student will have adequate knowledge to perform the experiments of different fields of physics with clear understanding of the theory behind the experiment. Student will know about advanced experiments based on their specialization paper.			
Credits: 4			Core Compulsory
Max. Marks: 100 **External Exam: 75** **Internal assessment: 25**			**Min. Passing Marks: 36**
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-4			
UNIT	**TOPIC**		**No. of Lectures**
	List of Experiments: (a) Advanced Electronics 1. Study of regulated power supply (723). 2. Study of operational amplifier (741). 3. Study of Timer (555). 4. A to D and D to A converter 5. 1 of 16 Decoder/Encoder 6. Study of Multiplexer/Demultiplexer 7. Study of Logic gates (Different types) 8. Study of Comparator and Decoder 9. Study of amplitude and frequency modulations and demodulations. 10. Study of different flip- flop circuits (RS, JK, Dk type, T-type, Master slave). 11. Study of Digital combinational and sequential circuits 12. Study of Microprocessor (8085) 13. Study of SCR, DIAC, TRIAC 14. Study of IC- Based Power supply 15. Microwave experiment. 16. Shift Registers 17. Fiber Optics communication		**60**
	List of Experiments: (b) Astrophysics 1. Study of Hubble's law (from given data) 2. Study of constant density neutron star 3. Study of the static parameters of a Neutron Star model with inverse square density distribution 4. Study of star cluster from a given data 5. Study of Extinction coefficients		**60**

	6. Study of variability of stars	
	List of Experiments: (c) High Energy Physics 1. Characteristic curve of a GM Detector and verification of inverse square law. 2. Characteristic curve of a GM Detector and Absorption coefficient of a using aluminum GM Detector. 3. Energy spectrum of gamma rays using gamma ray spectrometer. 4. Absorption coefficient of aluminum using gama-ray spectrometer. 5. Characteristics of Scintillation Detector. 6. Study of gama-gama unperturbed angular correlations. 7. Study of particle tracks using a Nuclear Emulsion Detector. 8. Classification of tracks in interaction with Nuclear Emulsion and determination of excitation energy.	**60**
	List of Experiments: (d) Spectroscopy 1. Study of the vibrational levels of Iodine. 2. Measurement of the fluorescence spectra of Uranyl Nitrate Hexahydrate. 3. Determination of the intrinsic life time for a dye molecule. 4. Determination of change in dipole moment in excited state using Solvatochromic shift method. 5. Measurement of non radiative decay rate for a known sample. 6. Determination of the quantum yield of known samples using steady state spectroscopy.	**60**
	List of Experiments: (e) Condensed Matter Physics 1. To determine the crystallite size of a nanomaterial using Debye Scherrer method 2. To determine the band gap energy of a material 3. To undersatand the microstructural features of ceramics 4. Study and analysis of FTIR spectra 5. To study I-V characteristics of a semiconductor 6. To study the surface morphology of a material be SEM 7. Synthesis of nanoparticle using sol-gel method 8. Determination of lattice parameters using XRD technique	**60**
Can be opted by **Bachelor in Science with Physics as major subject**		
Suggested Continuous Evaluation Methods:		
Course Prerequisites **Bachelor in Science with Physics as major subject**		
Suggested Equivalent Online Courses: 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		