



VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY
JNANASAGARA CAMPUS, BALLARI-583105

Department of Studies in Physics

III, IV, V and VI Semester Syllabus

Bachelor of Science

With effect from 2024-25

VSKUB SEP Curricular and Credits Structure under CBCS Scheme for the Three Years B.Sc. Undergraduate Programme w.e.f. from 2024-2025
(Three Major Combination)

I – VI Semester [Physics]

Semester	Course code	Title of the Course	Marks			Teaching hours/week			Credit	Duration of SEE (Hrs)
			IA	SEE	Total	L	T	P		
I	24MJP1L	Mechanics and Properties of Matter	20	80	100	4	0	0	4	03
	24MJP1P	Mechanics and Properties of Matter - Lab	10	40	50	0	0	4	2	03
II	24MJP2L	Thermal Physics and Waves	20	80	100	4	0	0	4	03
	24MJP2P	Thermal Physics and Waves - Lab	10	40	50	0	0	4	2	03
III	24MJP3L	Electricity and Magnetism	20	80	100	4	0	0	4	03
	24MJP3P	Electricity and Magnetism - Lab	10	40	50	0	0	4	2	03
	24MJP3S	Renewable energy and energy harvesting	10	40	50	1	0	2	2	1.5*
IV	24MJP4L	Wave Optics and Electronics.	20	80	100	3	0	0	3	03
	24MJP4P	Wave Optics and Electronics - Lab	20	80	100	3	0	0	3	03
	24MJP4S	Geophysics	10	40	50	1	0	2	2	1.5*
V	24MJP5L	Elements of Atomic, Molecular, and Laser Physics	20	80	100	3	0	0	3	03
	24MJP5P	Elements of Atomic, Molecular, and Laser Physics-Lab	10	40	50	0	0	4	2	03
	24MJP5E	Astronomy and Astrophysics	10	40	50	2	0	0	2	02
VI	24MJP6L	Modern Physics	20	80	100	3	0	0	3	03
	24MJP6P	Modern Physics – Lab	10	40	50	0	0	4	2	03
	24MJP6E	Medical Physics	10	40	50	2	0	0	2	02
	24MJP6R	Project	10	40	50	0	0	4	2	01
Total			240	960	1200	30	0	28	44	

Course Title: Electricity and Magnetism	Course code: 24MJPHYS3L
Total Contact Hours: 55	Course Credits: 04
Internal Assessment Marks: 20 marks	Duration of SEE: 03 hours
Semester End Examination Marks: 80 marks	

Course Outcomes (CO's):**At the end of the course, students will be able to:**

- Apply electric field concepts to physical systems.
- Interpret electrical components and their applications in electrical circuits.
- Apply magnetism concepts to physical systems.
- Apply vector analysis in electromagnet theory.
- Analyze the response of electrical circuits to alternating current.

Electricity and Magnetism

Unit	Description	Hours
1	<p>Electric charge and field: Coulomb's law and its limitations, Electric field strength, Electric field lines, Electric field due to a point charge, Electric field due to an electric dipole, Gauss's law and its applications: electric fields of a (i) uniformly charged sphere, (ii) uniformly charged hollow cylinder and (iii) an infinite flat sheet of charge. (5 hours)</p> <p>Electric potential, relation between field and potential, Potential due to a point charge (derivation), Potential due to an electric dipole and quadruple (derivation). Electrostatic potential energy of a system of charges (derivation). (6 hours)</p>	11
2	<p>Basic Electrical components: Definition of resistance, Capacitance and Inductance and their expressions. Colour code and tolerance, Ideas of reactance, impedance and admittance. Parallel plate capacitor- energy stored in capacitor (derivation), Energy stored in an inductor (derivation), loss of energy due to sharing of charges between two conductors (derivation).</p> <p>Network theorems: Thevenin's, Norton's and Reciprocity with examples, maximum power transfer theorem -statement with proof.</p> <p>Transient Currents: Growth and decay of current in RL-circuit (derivation with time constant definition), Charging and Discharging of capacitor through RC-circuit (derivation with time constant definition).</p>	11
3	<p>Magnetism: Statement of Biot-Savart law, Applications – (a) Magnetic field due to steady current in a long straight wire (b) Expression for force between two long straight conductors, Ampere's circuit law-Statement and proof, Applications – (a) Magnetic field near a long wire carrying current (b) Magnetic field due to a solenoid, Current loop as a dipole, Torque on a dipole. (5 hours)</p> <p>Electromagnetic induction: Faradays laws of electromagnetic induction, Deduction of Faradays laws from Lorentz force. Induction and Relative Motion: A Conducting rod moving in a uniform magnetic field, Concept of self-induction and mutual induction, Energy stored in a magnetic field (derivation). (6 hours)</p>	11

- 4 **Vector analysis and Electromagnetic theory:**
Vector Analysis: Scalar and Vector products, Gradient of a Scalar and its physical significance, Divergence of a Vector and its physical significance, Curl of a Vector and its Physical significance. Vector integration: line, surface and volume integrals of a vector field, Gauss divergence theorem and Stokes theorem (statements). (5 hours) 11
Electromagnetic theory: Equation of continuity, displacement current, Maxwell's equations - differential and integral forms and their physical significance, Equation of Electromagnetic waves in free space – speed of light (derivation), Derivation of Poynting theorem, Hertz experiment – Production and detection of electromagnetic waves. (6 hours)
- 5 **AC Circuits:** Review of Alternating Current. Average or mean value of AC and root mean square value of AC (derivation). Response of LR and RC circuits to sinusoidal voltages using j-operator. LCR series resonant circuit-expression for current and impedance using j-operator, concept of electrical resonance, expression for resonant frequency (derivation), expression for band width (derivation), Half- power frequencies (statement) and Q-factor (statement). LCR Parallel resonant circuit with resistance in the inductance arm- expression for resonant frequency. Power in LCR series circuit (derivation). RC Low pass and High pass filters - derivation of cut-off frequency. 11

Text Books:

1. Electricity and magnetism with Electronics by Dr.K.K.Tewari, S Chand Publication.
2. Electricity and magnetism by Brijlal and N Subrahmanyam, Rathanprakashan, nineteenth edition
3. Electricity and magnetism with electronics by R. Murugesan, S Chand Publication
4. College Physics Volume II by N.Sundararajan, George Thomas, Syed Azeez
5. Fundamentals of magnetism & Electricity by Vasudeva, S Chand Publication (2011)
6. Electricity and magnetism by N S Khare & S.S Srivastav, Atmaram & Sons, New Delhi
7. Electricity and magnetism by B.S.Agarwal, Kedarnath Ramanath Publication(2017)

Reference Books:

1. Physics-Part-II, David Halliday and Robert Resnick, Wiley Eastern Limited, 2001
2. Berkeley Physics Course, Vol-2, Electricity and Magnetism, Edward M Purcell, Special Edition, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008

Course Title: Electricity and Magnetism Lab	Course code: 24MJPYHS3P
Total Contact Hours: 56	Course Credits: 02
Internal Assessment Marks: 10	Duration of SEE: 03 hours
Semester End Examination Marks: 40	

Course Outcomes (CO's):

At the end of the course, students will be able to:

CO Statement

- 1 Design experiments in electricity and magnetism.
- 2 Execute experiments in electricity and magnetism.
- 3 Experimentally verify electrical theorems and measure electrical properties of materials.
- 4 Design and study the AC networks.

List of Experiments

1. Verification of Biot-Savart's law: Field along the axis of a circular coil.
2. Verification of Thevinin's theorem and Reciprocity theorem.
3. Verification of Norton's theorem.
4. Verification of Maximum power transfer theorem.
5. LCR Series resonance- determination of resonance frequency, band width and Q-factor.
6. LCR Parallel resonance- determination of resonance frequency, band width and Q-factor.
7. Variation of electrical conductivity with temperature in Metals.
8. Determination of time constant of an RC Circuit (both charging and discharging)
9. Frequency of an AC using Sonometer.
10. Determination of capacitance using De Sauty's DC bridge using spot Galvanometer.
11. De Sauty's A C Bridge – determination of capacitance of a given capacitor.
12. Impedance of series RC circuits- determination of frequency of AC.
13. Determination of cut-off frequency of RC Low-pass and High-pass filters.

Note:

1. Minimum of EIGHT experiments must be carried out.
2. Experiments may be added as and when required with the approval of BoS.

References:

1. Physics through experiments, by B.Saraf, 2013, Vikas Publications.
2. Lab manual of Physics for undergraduate classes, 1st Edition, Vikas Publications.
3. B.Sc. Practical Physics by CL Arora, Revised Edition 2007, S. Chand & Co.
4. An advanced course in practical physics, D. Chatopadhyay, PC Rakshit,
5. B.Saha, Revised Edition 2002, New Central Book Agency Pvt Ltd.

Course Title: Renewable energy and energy harvesting	Course code: 24MJPH3S
Total Contact Hours: 30	Course Credits: 02
Internal Assessment Marks: 10 marks	Duration of SEE: 1.5 hours
Semester End Examination Marks: 40 marks	

Course Outcomes (CO's):

At the end of the course, students will be able to:

1. Understand the fundamental principles of renewable energy sources and their importance in sustainable development.
2. Analyze different energy harvesting techniques and their efficiency for practical applications.
3. Apply concepts of solar, wind, and bioenergy systems in real-world energy solutions.
4. Evaluate the environmental and economic impact of renewable energy technologies.

Renewable energy and energy harvesting (24MJPH3S)

Unit	Description	Hours
1	Introduction to Renewable Energy Sources Overview of Energy Sources: Renewable vs. non-renewable energy, global energy demand, environmental impacts. Solar Energy: Basics of solar radiation, photovoltaic (PV) effect, solar thermal systems, applications. Wind Energy: Wind power generation principles, wind turbines, efficiency, and grid integration. Hydropower and Ocean Energy: Hydroelectric plants, tidal and wave energy, environmental considerations. (6 h) Hands on Session: 1) Solar Cell, 2) Wind energy, 3) Solar Thermal power. Modelling: 1) Hydropower, 2) Tidal (10 h)	16
2	Energy Harvesting Technologies Piezoelectric Energy Harvesting: Principles, materials, and applications. Thermoelectric Energy Conversion: Seebeck effect, thermoelectric generators, efficiency analysis. Electromagnetic Energy Harvesting: Basics of inductive and capacitive energy harvesting, micro-power applications. Bioenergy: Biomass energy conversion, biofuels, microbial fuel cells. (6 h) Hands on Session: 1) Seebeck effect, 2) Peltier effect 3) EMF induction Modelling: 1) Biomass, 2) Biofuel (8 h)	14

References

1. Boyle, G. (Ed.). (2012). *Renewable Energy: Power for a Sustainable Future* (3rd ed.). Oxford University Press.
2. Godfrey, B. (2017). *Renewable Energy Engineering and Technology: Principles and Practice*. CRC Press.
3. Priya, S., & Inman, D. J. (Eds.). (2009). *Energy Harvesting Technologies*. Springer.
4. Leonov, V., & Fiorini, P. (Eds.). (2018). *Energy Harvesting for Self-Powered Wearable Devices*. Springer.
5. Twidell, J., & Weir, T. (2015). *Renewable Energy Resources* (3rd ed.). Routledge.
6. Kalogirou, S. A. (2014). *Solar Energy Engineering: Processes and Systems* (2nd ed.). Academic Press.

Course Title: Wave Optics and Electronics	Course code: 24MJPHYS4L
Total Contact Hours: 55	Course Credits: 04
Internal Assessment Marks: 20 marks	Duration of SEE: 03 hours
Semester End Examination Marks: 80 marks	

Course Outcomes (CO's):

At the end of the course, students will be able to:

1. Use interference of light to interpret physical phenomena.
2. Analyse the difference between Fraunhofer and Fresnel diffractions.
3. Explain polarization of light and its application.
4. Analyse the performance of semiconductor devices and junction transistors.
5. Analyse digital electronic circuits.

Wave Optics and Electronics

Unit	Description	Hours
1	<p>Nature of light: The corpuscular theory of light, Huygen's wave theory, Maxwell's electromagnetic wave theory, Wave Particle Duality.</p> <p>Interference of light by division of wave front: Superposition of waves, coherent sources, conditions for sustained interference, Interference pattern produced on the surface of water, Interference of light waves by division of wavefront-Young's double slit experiment- derivation of expression for fringe width, Fresnel Biprism- Interference with white light.</p> <p>Interference of light by division of amplitude: Interference by a plane parallel film illuminated by a plane wave-Interference due to reflected light and transmitted light (derivation-condition for maximum and minimum intensity), Interference by a film with two non-parallel reflecting surfaces- expression for fringe width, color in thin films, Newton's rings by reflected light with theory.</p>	11
2	<p>Fraunhofer diffraction: Introduction, Fraunhofer diffraction- Single slit diffraction pattern-position of Maxima and Minima (Qualitative), Two slit diffraction pattern-position of Maxima and minima, Theory of plane diffraction Grating, Grating spectrum- normal and oblique incidence, Resolving power and dispersive power of a grating, Single slit; Double Slit.</p> <p>Fresnel Diffraction- Fresnel half period zones-Diffraction by a circular aperture-diffraction by an opaque disc, The zone plate, comparison between zone plate and convex lens.</p>	11
3	<p>Polarization: Review of fundamentals of polarization, Double refraction, uniaxial and biaxial crystals, positive and negative crystals, optic axis. Huygen's wave theory of double refraction. Huygens's construction of O and E wave front-in the case of optic axis (i) oblique to the refracting face, (ii) perpendicular to the refracting face and (iii) parallel to the refracting face, retarding plates-computation of the thickness of QWP and HWP, Theory of plane, elliptically and circularly polarized light. Production and analysis of plane, elliptical and circularly polarized light.</p> <p>Optical activity: Specific rotation- Fresnel's theory of optical rotation (derivation).</p>	11

- 4 **Semiconductor devices:** Review of Intrinsic and Extrinsic semiconductors, p-n junction and its Characteristics and Parameters, Diode approximations, Application of Diode: Half-wave rectifier and Full-wave rectifier, Zener diode voltage regulators: Regulator circuit with no load, Loaded Regulator. (5 hours)
Junction Transistors: Basics of Bipolar Junction Transistors (BJT), BJT operation, Common Base, Common Emitter and Common Collector Characteristics. Field Effect Transistor (FET) and its characteristics. Transistor as an Amplifier and Oscillator. (6 hours) 11
- 5 **Electronics:** Integrated Circuits (Analog and Digital), Operational Amplifier, Ideal characteristics of Op-Amp, Inverting and Non-Inverting Configurations. Applications- Voltage Follower, Addition and Subtraction. (4 hours) 11
Digital: Number Systems: Decimal Number System, Binary Number System, Converting Decimal to Binary, Hexadecimal Number System: Converting Binary to Hexadecimal, Hexadecimal to Binary. (3 hours)
Boolean Algebra Theorems: Digital Circuits: Logic gates, NOT Gate, AND Gate, OR Gate, NAND Gate, NOR Gate, Algebraic Simplification, Implementation of NAND and NOR functions, De Morgan's theorem. (4 hours)

Text Books:

1. Optics Ajoy Ghatak McGraw Hill Education (India) Pvt Ltd 2017
2. A text Book of Optics BrijLal, M N Avadhanulu & N Subrahmanyam S. Chand Publishing 2012.
3. A text Book of Optics by Khanna and Gulati.
4. College Physics Volume II by N.Sundararajan, George Thomas, Syed Azeez
5. Electronic Devices and Circuits, David A. Bell, 2004, PHI, New Delhi
6. Integrated Electronics, Jacob Millman and CC Halkias
7. Digital Fundamentals, Floyd, 2001, PHI, New Delhi
8. Basic Electronics by B. Basavaraj and H.N. Shivashankar, Vikas publication.

Reference Books:

1. Berkeley Physics Course – Waves, Frank S Crawford Jr. Tata Mc Graw-Hill Publishing Company Ltd., Special Indian Edition,. 2011
2. Optics Eugene Hecht Pearson Paperback 2019
3. Introduction To Optics Pedrotti and Frank L, Pearson India 3rd Edition
4. Fundamentals of Optics Francis Jenkins Harvey White McGraw Hill Education 2017

Course Title: Wave Optics and Electronics Lab	Course code: 24MJPHYS4P
Total Contact Hours: 56	Course Credits: 02
Internal Assessment Marks: 10	Duration of SEE: 03 hours
Semester End Examination Marks: 40	

Course Outcomes (CO's):

At the end of the course, students will be able to:

1. Explain the principles of interference, diffraction, and polarization in wave optics.
2. Perform and analyze experiments involving Newton's rings, and diffraction grating.
3. Construct and analyze basic electronic circuits using resistors, capacitors, diodes, and transistors.
4. Experiment with op-amps to understand their applications in amplification.
5. Study the characteristics of semiconductor diodes and BJTs through experiments.
6. Implement and verify logic gates and De Morgan's theorems.

List of Experiments

1. To determine the Cauchy constants of the material of a prism using mercury source.
2. To determine the wavelength of sodium source using Michelson's interferometer.
3. To determine wavelength of sodium light using Fresnel Biprism.
4. To determine wavelength of sodium light using Newton's Rings.
5. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
6. To determine wavelength of spectral lines of Hg source using plane diffraction grating.
7. To determine refractive index of ordinary and extra-ordinary rays using LASER light.
8. Zener Diode as voltage regulator-Load regulation and Line regulation.
9. Characteristics of BJT in Common Emitter Configuration.
10. Frequency response of CE Amplifier
11. Frequency response of CC Amplifier (Emitter Follower).
12. Full Wave Rectifier- without and with filters. Calculate ripple factor for all filters.
13. Applications of Operational Amplifier - Non-inverting and Inverting op-amp circuits
14. Operational Amplifier as Voltage follower, Adder and Subtractor circuits.
15. Verification of basic logic gates.
16. Verify De Morgan's theorems.

Note:

1. Minimum of EIGHT experiments must be carried out.
2. Experiments may be added as and when required with the approval of BoS.

References:

1. Basic Electronics Lab (P242) Manual 2015-16, National Institute of Science Education and Research, Bhubaneswar, 2015.
2. B.L. Worsnop, H.T. Flint, *Advanced Practical Physics for Students*, Methuen & Co., Ltd., London, 1962, 9e.
3. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015.
4. *Advanced Practical Physics for students* B.L. Flint and H.T. Worsnop Asia Publishing House. 1971.
5. A Text Book of Practical Physics I. Prakash & Ramakrishna Kitab Mahal, 11th Edition 2011.
6. *Advanced level Physics Practicals* Michael Nelson and Jon M. Ogborn Heinemann Educational Publishers, 4th Edition 1985.

Course Title: Geophysics	Course code: 24MJPH4S
Total Contact Hours: 30	Course Credits: 02
Internal Assessment Marks: 10 marks	Duration of SEE: 1.5 hours
Semester End Examination Marks: 40 marks	

Course Outcomes:

By the end of this course, students will be able to:

1. Understand fundamental geophysical concepts and Earth's physical properties.
2. Explain principles of seismic, gravitational, and electrical geophysical methods.
3. Apply geophysical techniques in earthquake studies, resource exploration, and environmental monitoring.

Geophysics (24MJPH4S)

Unit	Description	Hours
Unit 1	Introduction to Geophysics & Earth's Interior Introduction to Geophysics: Definition, branches, and applications, Earth's Internal Structure: Crust, mantle, and core (composition and properties), Seismology & Earthquakes: Types of seismic waves (P, S, Surface waves), Earthquake magnitude and intensity (Richter & Mercalli scales), Seismographs and earthquake monitoring, Plate Tectonics & Geodynamics: Continental drift, seafloor spreading, and tectonic activity (6 h) Hands on Session: Use of 1) Magnetometer, 2) GPS, and 3) soil testing parameters Modelling: Earth's Internal Structure. Survey of earthquake events (10 h)	16
Unit 2	Gravity, Properties of Earth and Environmental geophysics Gravity & Earth's Shape: Gravity anomalies and their significance, Isostasy and buoyancy, Geomagnetism & Paleomagnetism: Earth's magnetic field, Magnetic reversals and their geological significance, Electrical Properties of Earth: Conductivity, resistivity, and electromagnetic properties, Ground Penetrating Radar (GPR) and its environmental applications. Environmental geophysics (landfill detection, groundwater contamination), Engineering Geophysics: Geophysical techniques in civil engineering, tunnel & dam site investigations (6 h) Hands on Session: 1) Measurement of g, 2) measurement of B_H 3) water testing parameters Modelling: 1) Tunnel & 2) Dam (8 h)	14

Reference Books:

1. Telford, W. M., Geldart, L. P., & Sheriff, R. E. (1990). *Applied Geophysics*. Cambridge University Press.
2. Fowler, C. M. R. (2005). *The Solid Earth: An Introduction to Global Geophysics*. Cambridge University Press.
3. Dobrin, M.B. (1988). *Introduction to Geophysical Prospecting*. McGraw Hill.

Course Title: Elements of Atomic, Molecular & Laser Physics	Course code: 24MJPHYS5L
Total Contact Hours: 56	Course Credits: 04
Internal Assessment Marks: 20 marks	Duration of SEE: 03 hours
Semester End Examination Marks: 80 marks	

Course Outcomes (CO's):

After the completion of the course, the student will be able to

1. Describe atomic properties using basic atomic models.
2. Interpret atomic spectra of elements using vector atom model.
3. Interpret molecular spectra of compounds using basics of molecular physics.
4. Explain laser systems and their applications in various fields.

ELEMENTS OF ATOMIC, MOLECULAR & LASER PHYSICS [24MJPHYS5L]

Unit	Description	Hours
1	Basic Atomic models: Thomson's atomic model. Rutherford atomic model – Experiment, Theory of alpha particle scattering (Expression for impact parameter), Rutherford scattering formula. Bohr's atomic model – postulates, Derivation of expression for radius, total energy of electron, interpretation of Hydrogen spectrum. Effect of nuclear motion on atomic spectra (derivation). Ritz combination principle. Correspondence principle. Critical potentials – excitation potential and ionisation potential, atomic excitation and its types, Franck-Hertz experiment. Sommerfeld's atomic model – Derivation of condition for allowed elliptical orbits.	14
2	Vector atomic model and optical spectra: Vector atom model –fundamentals, spatial quantisation, spinning electron. Quantum numbers associated with vector atomic model. Pauli's exclusion principle. Magnetic dipole moment due to orbital motion of electron (derivation). Magnetic dipole moment due to spin motion of electron. Lande g-factor and its calculation for different states. Stern-Gerlach experiment – Principle, Experimental arrangement and derivation for the deviation produced by the dipole. Fine structure of spectral lines with examples. Spin-orbit coupling/Spin-Orbit Interaction (qualitative). Coupling schemes – L-S and j-j schemes. Optical spectra – spectral terms, spectral notations, selection rules, intensity rules. Fine structure of the sodium D-line. Zeeman effect: Types, Experimental study, Zeeman shift expression (derivation). Stark effect: Experimental study, Types and examples.	14
3	Molecular Physics Types of molecules based on their moment of inertia. Types of molecular motions and energies. Born-Oppenheimer approximation. Origin of molecular spectra. Nature of molecular spectra. Theory of rigid rotator – energy levels and spectrum, Qualitative discussion on non-rigid rotator. Theory of vibrating molecule as a simple harmonic oscillator – energy levels and spectrum. Electronic spectra of molecules – fluorescence and phosphorescence. Raman effect – Stoke's and anti-Stoke's lines,	14

characteristics of Raman spectra, classical and quantum theories, Experimental study of Raman effect; Applications of Raman effect.

4 **Laser Physics**

Characteristics of laser light. Interaction of radiation with matter - Induced absorption, spontaneous emission and stimulated emission with mention of rate equations. Einstein's A and B coefficients – Derivation of relation between Einstein's coefficients and radiation energy density. Population inversion. Methods of pumping. Metastable states. Requisites of laser – 14 energy source, active medium and laser cavity. Difference between Three level and four level lasers with examples. Types of lasers with examples; Construction and Working principle of Ruby laser, He-Ne laser. Application of lasers (qualitative) in science & research.

Text Books:

1. Modern Physics, R. Murugesan, Kiruthiga Sivaprakash, Revised Edition, 2009, S. Chand & Company Ltd.
2. Atomic & Molecular spectra: Laser, Raj Kumar, Revised Edition, 2008, Kedar Nath Ram Nath Publishers, Meerut.
3. Atomic Physics, S.N. Ghoshal, Revised Edition, 2013, S. Chand & Company Ltd.
4. Concepts of Atomic Physics, S.P. Kuila, First Edition, 2018, New Central Book Agency (P) Ltd.
5. Concepts of Modern Physics, Arthur Beiser, Seventh Edition, 2015, Shobhit Mahajan, S. Rai Choudhury, 2002, McGraw-Hill.
6. Fundamentals of Molecular Spectroscopy, C.N. Banwell and E.M. McCash, Fourth Edition, 2008, Tata McGraw-Hill Publishers.
7. Elements of Spectroscopy – Atomic, Molecular and Laser Physics, Gupta, Kumar and Sharma, 2016, Pragati Publications.

Course Title: Elements of Atomic, Molecular & Laser Physics Lab	Course code: 24MJPHYS5P
Total Contact Hours: 56	Course Credits: 02
Internal Assessment Marks: 10	Duration of SEE: 03 hours
Semester End Examination Marks: 40	

Course Outcomes (CO's):

At the end of the course:

1. Students would be able to understand Basic experiments of modern physics such as: Determination of Plank's constants, Determination of ionization potential, Rydberg's constant of H-spectrum, Single and double slit diffraction, Photo electric effect and determination of charge of the electron and e/m of the electron.
2. Students would able to understand the applications of LASER and measurement of various physical quantities using LASER source.

List of Experiments

1. To determine wavelength of spectral lines of mercury source using spectrometer.
2. To determine dispersive power of a plane diffraction grating.
3. To determine the value of Rydberg's constant using diffraction grating and hydrogen discharge tube.
4. To determine the wavelength of emission line of Hydrogen atom.
5. To determine fine structure constant using fine structure separation of sodium D-lines using a plane diffraction grating.
6. To determine the ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of Iodine vapour.
8. To determine the force constant and vibrational constant for the iodine molecule from its absorptionspectrum.
9. To determine the wavelength of laser using diffraction by single slit.
10. To determine the wavelength of laser using diffraction by double slit.
11. To determine wavelength of He-Ne laser using plane diffraction grating.
12. To determine angular spread of laser using plane diffraction grating.
13. Refractive index of liquid using Laser Source.
14. Study of Raman scattering by CCl_4 using laser and spectrometer/CDS.
15. Charge of an electron by dispersion measurement.
16. Spectral response of LDR.

NOTE: Students have to perform at-least EIGHT Experiments from the above list.

References:

1. Practical Physics, D.C. Tayal, 1st Millennium Edition, 2000, Himalaya Publishing House.
2. B.Sc. Practical Physics, C.L. Arora, Revised Edition, 2007, S. Chand & Comp. Ltd.
3. An Advanced Course in Practical Physics, D. Chatopadhyaya, P.C. Rakshith, B. Saha, Revised Edition, 2002, New Central Book Agency Pvt. Ltd.
4. Physics through experiments, B. Saraf, 2013, Vikas Publications.

Department Name: Physics

Course Title: Astronomy and Astrophysics	Course Code: 24MJPH5E
Total Contact Hours: 30 Hours	No. of Credits: 02
Formative Assessment Marks: 10	Duration of ESA/Exam: 02 Hours
Summative Assessment Marks: 40	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Understand the methods of measuring stellar brightness, distances, and classification using the Hertzsprung-Russell diagram.
2. Explain the life cycle of stars, from formation to end stages like white dwarfs, neutron stars, and black holes.
3. Describe the structure of the Sun, classification of galaxies, and the evolution of the universe based on the Big Bang Theory.

Astronomy and Astrophysics (24MJPH5E)

Unit	Description	Hours
1	Stellar Magnitudes, Distances, and Classification: Stellar magnitude sequence, Absolute magnitude and the distance modulus, Stellar Parallax (Trigonometric) and the units of stellar distances (Parsecs, Light years), Harvard system of spectral classification, The Hertzsprung-Russell (HR) diagram.	10
2	Star Formation and Evolution: Early stage of star formation, protostars, fragmentation, Stellar nucleosynthesis and evolution on the main sequence, degenerate free electron gas, Evolution beyond the main sequence, Population I and II stars, White dwarfs, Pulsars, Magnetars, Neutron star, Black holes, Supernova, Variable stars.	10
3	The Sun, Galaxies, and the Universe: Solar atmosphere: Photosphere, Chromosphere, Corona, Dynamo mechanism for magnetic field enhancement, Sunspots and the Solar Cycle, the structure and contents of Milky way Galaxy, Hubble's classification of Galaxies, big bang theory and the origin of the early universe.	10

References:

1. An Introduction to Astrophysics Baidyanath Basu, Second Edition, PHI Learning Pvt. Ltd, (2010).
2. Stars and Galaxies, K.D. Abhyankar, University Press, (2001).
3. Introduction to Stellar Astrophysics, E. Bohm-Vitense, 3rd Vol., Cambridge University Press, (1992).
4. Astrophysics and Stellar Astronomy, T.L. Swihart, Wiley (1968).
5. Galaxies; their Structure and Evolution, R.J. Taylor, Cambridge University Press, (1993).
6. Solar System Astrophysics, J.C. Brandt, P. Hodge, McGraw-Hill, (1964).
7. Introduction to Modern Astrophysics, Ostlie and Carroll, Pearson, (2006).
8. A Textbook of Astronomy and Astrophysics with Elements of Cosmology, V.B. Bhatia, Alpha Science International Ltd., (2001)
9. C. R. Kitchin: Astrophysical Techniques, 4th Edition, CRC Press, (2003).

Course Title: Modern Physics	Course code: 24MJPHYS6L
Total Contact Hours: 56	Course Credits: 04
Internal Assessment Marks: 20 marks	Duration of SEE: 03 hours
Semester End Examination Marks: 80 marks	

Course Outcomes (CO's):

At the end of the course, students will be able to:

1. Apply relativity principles and Lorentz transformations.
2. Explain energy bands and material classifications.
3. Analyze electronic and nanoscale properties.
4. Understand superconductivity and its applications.
5. Apply quantum mechanics and nuclear physics concepts.

MODERN PHYSICS [24MJPHYS6L]

Unit	Description	Hours
1	<p>Relativity: Newtonian principle of relativity. Inertial and Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame-Expression for Coriolis force.</p> <p>Special Theory of Relativity: Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformation equations (Quantitative). Relativity of Simultaneity. Lorentz contraction. Time dilation. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass energy Equivalence. Transformation of Energy and Momentum. Relativistic Doppler effect: Longitudinal Doppler Effect-Expression for apparent frequency.</p>	14
2	<p>Band theory of solids: Origin of bands in solids, intrinsic and extrinsic semiconductors, Electrical conductivity of Intrinsic Semiconductor-expression for carrier concentration in intrinsic semiconductors-Band Gap (derivation), Fermi level in case of intrinsic and extrinsic semiconductors (qualitative), Hall effect - expression for Hall coefficient, experimental determination and applications.</p> <p>Superconductivity: Experimental facts (Transition temperature, persistent current, Isotope effect, Meissner effect), Critical magnetic field, BCS theory, Type I & Type II superconductors, Applications: Superconducting Magnet, Maglev & Squids (qualitative).</p> <p>Magnetic materials: Types and Origin of Dia, Para and Ferromagnetism (domain theory-qualitative) on the basis of electronic theory. Langevin's theory of Diamagnetism and Para magnetism, Curie Law.</p> <p>Nanomaterials: Introduction, Quantum nano structures: quantum wells, wires and dots. Graphene and Fullerene (qualitative), Applications of Nanomaterials.</p>	14
3	<p>Quantum mechanics:</p> <p>Matter Waves: Concept of Matter Waves- de Broglie hypothesis, Characteristics of matter waves, Group and phase velocity of matter Waves, relation between group and phase velocity (derivation), experimental evidence for existence of matter waves Davison-Germer Experiment with Theory.</p> <p>Heisenberg's Uncertainty Principle: Statement, explanation and</p>	14

illustration-gamma ray microscope experiment (quantitative), Applications of the Uncertainty Principle – The size of an atom, non-existence of electrons inside the nucleus.

Principles of Quantum Mechanics: Concept of wave function, Properties of wave function, Physical significance (Born's interpretation of the wave function), Normalisation of wave function. Basic postulates of quantum mechanics.

Schrodinger Wave Equation: Schrodinger's time independent wave Equation (derivation), Application of Schrodinger's equation to particle in one dimensional box - wave function & energy values (derivation).

4 **Nuclear Physics:**

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Radioactivity: Theory of successive disintegration, radioactive equilibrium (secular and transient). α -decay- Characteristics of alpha spectrum, Range and disintegration energy of α -particle, Geiger- Nuttal law, Gamow's theory of α -decay (brief).

β -decay, Types of β -decay (electron decay, positron decay and electron capture). Characteristics of β -spectrum and Pauli's neutrino hypothesis.

Detectors: GM Counter, Scintillation counter and solid-state detector.

Accelerators: Construction, working and theory of Linear Accelerator.

Nuclear reactions: Types of nuclear reactions, Conservation laws in nuclear reactions, expression for Q-value of a nuclear reaction.

Text Books:

1. Solid State Physics-R. K. Puri and V.K. Babber., S.Chand publications, 1st Edition(2004).
2. Fundamentals of Solid State Physics-B.S. Saxena, P.N. Saxena, Pragati Prakashan Meerut
3. Nuclear Physics, Irving Kaplan, Narosa Publishing House
4. Introduction to solid State Physics, *Charles Kittel*, VII edition, (1996)
5. Solid State Physics- **A J Dekker**, MacMillan India Ltd, (2000)
6. Concepts of Modern Physics, Arthur Beiser, McGraw-Hill, 2009.
7. Quantum Physics, Berkeley Physics Course Vol. 4. E.H. Wichman, Tata McGraw-Hill Co., 2008.
8. Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A. Moore, McGraw Hill, 2003.
9. College Physics Volume III, by N Sundararajan, George Thomas, Syed Azeez.
10. Modern Physics by R. Murugesan and ER. Kiruthiga Sivaprasath.

Course Title: Modern Physics Lab	Course code: 24MJPHYS6P
Total Contact Hours: 56	Course Credits: 02
Internal Assessment Marks: 10	Duration of SEE: 03 hours
Semester End Examination Marks: 40	

Course Outcomes (CO's):**At the end of the course, students will be able to:**

1. Determine the band gap of a semiconductor material using temperature-dependent conductivity measurements.
2. Understand the working principles of semiconductor devices and their applications in modern electronics.
3. Analyze the absorption of radiation in different materials and determine attenuation coefficients.
4. Study radioactive decay and determine half-lives of isotopes using a Geiger-Müller counter.
5. Measure the stopping potential and determine Planck's constant.
6. Understand the dependence of kinetic energy of photoelectrons on the frequency of incident light.

List of Experiments

1. Determination of Planck constant and work function of the material of the cathode using Photo-electric cell.
2. To find the value of e/m for an electron by Thomson's method using bar magnets.
3. A code in C/C++/Scilab to find the first seven eigen states and eigen functions of Linear Harmonic Oscillator by solving the Schrödinger equation.
4. A code in C/C++/Scilab to plot and analyse the wavefunctions for particle in an infinite potential well.
5. Hall Effect in semiconductor: determination of mobility, hall coefficient.
6. Energy gap of semiconductor (diode/transistor) by reverse saturation method
7. Energy gap of Thermistor
8. Fermi Energy of Copper
9. Study the characteristics of Geiger-Müller Tube. Determine the threshold voltage, plateau region and operating voltage.
10. Study the absorption of beta particles in aluminium foils using GM counter.
11. Verification of Inverse Square law of radiation.
12. Study the absorption of beta particles in thin copper foils using G M counter and determine mass attenuation coefficient.
13. Study the attenuation of gamma rays in lead foils using Cs-137 source and G M counter. Calculate mass attenuation coefficient of Lead for Gamma.
14. Determine the end point energy of Tl-204 source by studying the absorption of beta particles in aluminium.
15. Study the attenuation of absorption of gamma rays in polymeric materials using Cs-137 source and G M counter.
16. Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method).

Note:

1. Minimum of EIGHT experiments must be carried out.
2. Experiments may be added as and when required with the approval of BoS.

References:

1. IGNOU: Practical Physics Manual
2. Saraf: Experiment in Physics, Vikas Publications
3. S.P. Singh: Advanced Practical Physics
4. Melissos: Experiments in Modern Physics
5. Misra and Misra, Physics Lab. Manual, South Asian publishers, (2000)
6. Gupta and Kumar, Practical physics, Pragati prakashan, (1976)
7. B.Sc Practical Physics by C.L Arora.
8. B.Sc Practical Physics by Harnam Singh and P.S Hemne.
9. Practical Physics by G.S Squires.
10. Scilab Manual for CC-XI: Quantum Mechanics & Applications (32221501) by Dr Neetu Agrawal, Daulat Ram College of Delhi.
11. Scilab Textbook Companion for Quantum Mechanics by M. C. Jain.
12. Computational Quantum Mechanics using Scilab, BIT Mesra.
13. Advanced Practical Physics for Students by Worsnop B L and Flint H T.

Course Title: Medical Physics	Course Code:24MJPH6E
Total Contact Hours: 30 Hours	Number of Credits:2
Formative Assessment Marks-10	Duration of ESA/Exam: 2 Hours
Summative Assessment Marks-40	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Understand the electromagnetic spectrum and radiation properties.
2. Analyze radiation instruments used in advanced therapy.
3. Apply computational methods in CT, MRI, and Ultrasound Imaging.

Medical Physics (24MJPH6E)		
Unit	Description	Hours
1	<p>Radiological Physics Electromagnetic spectrum, Production, properties and classification of electromagnetic radiation, Different sources of radiation - radio waves, microwaves, infrared, visible, ultra violet radiation, X and Gamma rays- production, physical properties and their interaction with tissues, Radioactivity - General properties of alpha, beta and gamma rays, Artificial radioactivity.</p> <p>Ionizing Radiation Quantities and Units Dosimetric Quantities: Exposure, Absorbed Dose, Kerma, Terma, Charged particle equilibrium (CPE) – Relationship between Kerma, absorbed dose and exposure under CPE. Radioactivity Units: Becquerel & Curie, exposure units - C/kg & Roentgen, Gray & Rad, Sievert & Rem. (Ref. 1,2,3)</p>	10
2	<p>Radiation Detectors Basic principles of radiation detection and applications of Gas Filled detectors: Ionization chambers, Types of instruments which uses gas filled detectors – radiation dosimeters, survey meters, Solid State Detectors: Scintillation detectors – Advantages of scintillation detectors, Semiconductor detectors and its application for gamma spectrometry. Instruments for counting and spectrometry - Portable counting systems for alpha and beta radiation - Gamma ray spectrometers – Single and Multichannel Analyser – HPGe – Liquid scintillation counting system (Organic/Inorganic). (Ref. 3,4,5)</p>	10
3	<p>Physics of medical imaging Principle of Diagnostic Radiology- Radiography techniques: objectives of radio-diagnosis, Interactions of X-rays with human body, factors affecting image quality- patient dose versus image quality. Computed Tomography (CT): Principle, CT imaging system, image reconstruction and processing, acquisition and image quality. Magnetic Resonance Imaging (MRI)-Qualitative, Imaging process, MRI safety, and techniques involved MR image acquisition and reconstruction, safety and applications of MRI in radiotherapy for treatment planning. Ultrasound imaging (US), production of ultrasound, image formation, US imaging in radiotherapy for treatment planning. (Ref. 6,7)</p>	10

References:

1. Radiation Physics in Radiology, Oliver R., Blackwell Science Ltd; 1st Edition, 1966.
2. Radiation Physics for Medical Physicists, E.B. Podgarsak, Springer Verlag, 1st Edition, 1996.
3. Radiation Detection and Measurement, Glenn F. Knoll, 4th Ed., John Wiley & Sons Inc., 2010.
4. Nicholas Tsoufanidis, Measurement and Detection of Radiation, 2nd Ed., Taylor and Francis, 1995.
5. Radiation and Detectors: Introduction to the Physics of Radiation and Detection Devices by Lucio Cerrito (Author), May 2017.

6. Dance, D.R., Christofides, S., Maidment A.D.R., McLean, I.D., Ng.K.H., Diagnostic radiology physics : a Handbook for teachers and students, International Atomic Energy Agency,Vienna, 2014.
7. Christensen's introduction to the physics of diagnostic radiology, Curry, T.S., Dowdey, J.E., Murry, R.C., Philadelphia: Lea &Febiger, 4th Edition, (1990).