Faculty of Science &Technology

Template for Defining Course: T.Y.B.Sc. Physics (NEP-2023 Pattern) June2025

Course Pattern: CBCS Pattern				
Course Part Definition	**Course Part Term Definition**			
T.Y.B.Sc.	**Sem-V**		**Sem-VI**	
Min Papers-20	Min Papers	10	Min Papers	10
Max Papers-20	Max Papers	10	Max Papers	10
Min Marks-440	Min Marks	220	Min Marks	220
Max Marks-1100	Max Marks	550	Max Marks	550
Total Credits-44	Total Credits	22	Total Credits	22

SEM V												
Course	**Paper Name**	**Paper Type (General/Special/Skill/OEC/AE/VEC/IKS**	**Credits**	**Lectures (Hr. per week)**	**Teaching Learning Method**	**Assessment Method (Theory/Practical)**	**Total Marks**		**External (UA)**		**Internal (CA)**	
							Max Marks	**Min Marks**	**Max Marks**	**Min Marks**	**Max Marks**	**Min Marks**
	1.Major Core Subject Group *(Select any One Group)*											
Major	PHY-MJ-301: Mathematical Physics	Major	**2**	**2**	**Theory**	**Theory**	50	20	30	12	20	8
Major	PHY-MJ-302: Solid State Physics	Major	**2**	**2**	**Theory**	**Theory**	50	20	30	12	20	8
Major	PHY-MJ-303:Atomic and Molecular Physics	Major	**2**	**2**	**Theory**	**Theory**	50	20	30	12	20	8
Major	PHY-MJP-304 Physics Practical Paper-VII	Major	**2**	**4**	**Practical**	**Practical**	50	20	30	12	20	8
Major	PHY-MJP-305 Physics Practical Paper-VIII	Major	**2**	**4**	**Practical**	**Practical**	50	20	30	12	20	8
	2.Vocational/Skill Enhancement course Group											
VSC	PHY-VSCP-306 Experimental Skills in Physics-I	VSCP	**2**	**4**	**Practical**	**Practical**	50	20	30	12	20	8
	3.MinorSubjectGroup *(Select any One)*											
Minor	PHY-MN-311Renewable Energy Sources	Minor	**2**	**2**	**Theory**	**Theory**	50	20	30	12	20	8
Minor	PHY-MNP-312 Lab on Renewable Energy Sources	Minor	**2**	**4**	**Practical**	**Practical**	50	20	30	12	20	8
	4.Discipline Elective course Group											
EC	PHY-EC-321 NanoMaterials: Introduction and Synthesis	EC	**2**	**2**	**Theory**	**Theory**	50	20	30	12	20	8
EC	PHY-ECP-322 Lab on PHY-EC-321 NanoMaterials: Introduction and Synthesis	EC	**2**	**2**	**Practical**	**Practical**	50	20	30	12	20	8
	5.Field Project / OJT / Int.											
FP	PHY-FP-341Field Project	FP	4	**8**	**Practical**	**Practical**	100	40	60	24	40	16
		Total Credits	**24**									

SEM VI													
Course	**Paper Name**	**Paper Type (General/Special/Skill/OEC /AE/VEC/IKS**	**Credits**	**Lectures(Hr.perweek)**	**Teaching Learning Method**	**Assessment Method (Theory/ Practical)**	**Total Marks**		**External (UA)**		**Internal (CA)**	
							Max Marks	**Min Marks**	**Max Marks**	**Min Marks**	**Max Marks**	**Min Marks**
	1. Major Core Subject Group *(Select any One Group)*											
Major	PHY-MJ-351 Quantum Mechanics	Major	**2**	**2**	**Theory**	**Theory**	50	20	30	12	20	8
Major	PHY-MJ-352 Elements of Nuclear Physics	Major	**2**	**2**	**Theory**	**Theory**	50	20	30	12	20	8
Major	PHY-IKS-353 IKS in Physics	Major	**2**	**2**	**Theory**	**Theory**	50	20	30	12	20	8
Major	PHY-MJP-354 Physics Practical Paper-IX	Major	**2**	**4**	**Practical**	**Practical**	50	20	30	12	20	8
Major	PHY-MJP-355 Physics Practical Paper-X	Major	**2**	**4**	**Practical**	**Practical**	50	20	30	12	20	8
	2. Vocational /Skill Enhancement course Group *(Select any One)*											
VSC	PHY-VSCP-356 Experimental Skills in Physics-II	VSCP	**2**	**4**	**Practical**	**Practical**	50	20	30	12	20	8
	3. Minor Subject Group *(Select any One)*											
Minor	PHY-MN-361 Digital electronics -I	Minor	**2**	**2**	**Theory**	**Theory**	50	20	30	12	20	8
Minor	PHY-MNP-362 Lab on Digital electronics -I	Minor	**2**	**4**	**Practical**	**Practical**	50	20	30	12	20	8
	4. Discipline Elective course Group											
EC	PHY-EC-371 Nano Materials: Characterization and Applications	EC	**2**	**2**	**Theory**	**Theory**	50	20	30	12	20	8
EC	PHY-ECP-372 Lab on Nano Materials: Characterization and Applications	EC	**2**	**2**	**Practical**	**Practical**	50	20	30	12	20	8
	5.Field Project/OJT/Int.											
OJT	PHY-OJT-391 On Job Training/Internship	OJT	4	**8**	**Practical**	**Practical**	100	40	60	24	40	16
		Total Credits	**24**									

School of Physical Sciences

PRATAP COLLEGE (Autonomous), AMALNER

Affiliated to KBC North Maharashtra University, Jalgaon

'A+' Grade NAAC Re-Accredited (3rd Cycle)

(CGPA 3.52)

SYLLABUS

FOR

T.Y. B.Sc. (PHYSICS)

As per NEP 2020

(With effect from June 2025)

Preamble

Pratap College, Amalner got Autonomous status from the academic year 2019-20. The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning process and examination & evaluation systems. Pratap College Amalner is affiliated to Kavayitri Bahinabai Chaudhari North Maharashtra University Jalgaon as per the directions of UGC. Pratap (Autonomous) College, Amalner is going to implement the National Education Policy (NEP 2020) to undergraduate program. The main objective of the framing the syllabi of T.Y.B.Sc. (Physics) is to create skilled minds and therefore expectation is to equip the students with the knowledge and understanding of concepts of physics rather than the ability to remember facts so that they may have a reasonable comprehensive and complete grasp of principles of Physics. It is expected that the students studying Physics will apply investigations and problem solving skills, effectively communicate the theoretical concepts, and appreciate the contribution that the study of Physics makes to our understanding of the world.

Board of Studies (Physics),

Pratap (Autonomous) College, Amalner

OBJECTIVES

1. To provide education in physics of the highest quality at the undergraduate level and generate graduates of the caliber sought by industries and public service as well as academic teachers and researchers of the future.
2. To acquire deep knowledge in fundamental aspects of Physics and basic knowledge in the specialized thrust areas like Basic electronics, Wave Oscillations, Electrical Circuits and Networks, Renewable Energy Sources , Thermal Physics, Sensors: Science and Technology
3. To develop ability among the students to identify, remember and grasp the meaning of basic facts, concepts and principles of Physics.
4. To develop observational skills, confidence in using scientific equipment and relate the knowledge of scientific concepts to quantitative and physical measurement.
5. Acquire knowledge, skills, working methods and ways of expression which will reflect on all round development of the students' attitudes towards scientific thinking and its applications.
6. To develop attitudes such as concern for accuracy and precision, objectivity, andEnquiry.
7. The overall aim is to provide comprehensive knowledge and understanding in the relevant fields and enable students to pursue the physics subject at an advanced level later and to attract outstanding students from all back grounds.

Semester V: (DSC): Physics DSC-15: **PHY-MJ-301 Mathematical Physics**
(Credits: 02) (30 Hours 30 Marks)

Course description:

This course is aimed at introducing the concepts of Mathematical physics to Under Graduate students.

Course objectives:

1. To impart knowledge of basic concepts in Mathematical physics.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.

Course outcome:

Learner will be able to ….

1. Apply the concept and knowledge of Mathematical physics to understand and solve real life problems.
2. Understanding of the course will create scientific temperament.

Unit 1: Vector Analysis ***(6H, 6M)***

Gauss divergence theorem, Stokes' theorem, Green's first and second theorem, Green's theorem in the plane. (Statements only)

Unit 2: Differential Equation ***(8H, 8M)***

Introduction to Cartesian (X, Y, Z), Spherical polar (r, θ, φ) and Cylindrical (ρ, φ, z) co-ordinate systems and their transformation equations, Degree, order, linearity and homogeneity of partial differential equation, Method of separation of variables in Cartesian, Spherical polar and Cylindrical co-ordinate system (Laplace's equation).

Unit 3: Special Functions **(6H, 6M)**

Generating functions for Legendre Polynomial $P_n(x)$, Hermite polynomial $H_n(x)$.

Proof of following properties

1) $(n+1)\,P_{n+1}(x) = (2n+1)\,xP_n(x) - nP_{n-1}(x)$.

2) $H_{n+1}(x) = 2x\,H_n(x) - 2n\,H_{n-1}(x)$.

Unit 4: Complex Analysis ***(10H, 10M)***

Complex numbers and their graphical representation, Argand diagram, Conjugate of a complex number, Basic mathematical operations with complex numbers, Euler's formula, De-Moivre's theorem, Functions of complex variables, Analyticity and Cauchy - Riemann conditions, Singular functions, Examples.

(Total: 30 Hours, 30 Marks)

References:

1. Mathematical Physics: B.S. Rajput, Pragati Prakashan (19th Edition, 2007).
2. Mathematical Physics: B. D. Gupta.
3. Mathematical Methods for Physics: G. Arfken, Hens Weber (4th Edition, 1995).
4. Mathematical Methods in the Physical Science: Mary L. Boas.
5. Vector Analysis: Murray R. Spiegal, Schaum's series.
6. Introduction to Special theory of Relativity – Robert Resnick, Wiley Eastern Ltd.
7. Mathematical physics: Ghatak
8. Complex variables and applications: J. W. Brown

Semester V: DSC-16: PHY-MJ-302 Solid State Physics
Credits: 02; Hours: 30; Marks: 30

Course description:

This course is aimed at introducing the fundamentals of solid state physics to Under Graduate students.

Course objectives:

1. To impart knowledge of basic concepts in solid state physics.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.

Course outcome:

Learner will be able to ….

1. Apply the concept of use of knowledge of solid state physics to real life problems.
2. Understanding of the course will create scientific temperament.

Unit I Crystal Structures

Introduction , lattice, basis and Crystal structure, unit cell ,lattice parameters, translational vector and symmetry operations, 2D & 3D Bravais lattices, Miller indices & Crystal planes, Interplanar spacing, Number of atoms per unit cell, co- ordination number, atomic radius and packing fraction for SC, BCC and FCC structures, crystal structures of NaCl, ZnS and CsCl materials , concept of reciprocal lattice and its properties. (10H, 10M)

Unit 2: X-Ray Diffraction and Experimental Methods

Origin of x-ray, X ray spectrum , Moseley's law, Bragg's law, Bragg's diffraction condition in direct lattice and reciprocal lattice, Ewald's construction, Brillouin zones, X-ray diffraction methods: Laue method, Rotating crystal method and Powder crystal method, Analysis of cubic crystal by powder method. (09H, 10M)

Unit 3: Free Electron theory of metals and Band theory of solids

Assumptions of Classical and Somerfield's Free Electron model, Energy levels and Density of States (1-D and 2-D), Fermi energy, Fermi level, Hall Effect, Mobility, Hall Angle. Band Theory of Solids: Nearly free electron model, Origin of energy gap, Energy bands in Solids, Distinction between metal, semiconductor and insulator, Problems. (11H, 10 M)

References:

1. Introduction to Solid State Physics: Charles Kittle.
2. Solid state Physics: R. L. Singhal
3. Solid State Physics: S.L. Gupta, V. Kumar.
4. Solid State Physics: S.L. Kakani, C. Hemrajan
5. Solid State Physics: R.L.Singhal, Kedar Nath, Ram Nath & Co.
6. Concepts of Solid State Physics: J.N. Mandal, Pragati Prakashan, Meerut

DSC-17: PHY-MJ-303 Atomic and Molecular physics
(Credits: 02) :(30 hours, 30 Marks)

Course description:
This course is aimed at introducing the fundamentals of Atomic and Molecular Physics to Under Graduate students.

Course objectives:

1) To impart knowledge of basic concepts in Atomic and Molecular Physics.
2) To provide the knowledge and methodology necessary for solving problems in Physics.
3) The course also involves the related experiments based on the theory.

Course outcome:
Learner will be able to ….

1) Apply the concept and knowledge of Atomic and Molecular Physics to understand and solve the real life problems.
2) Understanding of the course will create scientific temperament.

Unit 1: Vector Atom Model
Introduction, Quantum numbers and their physical interpretation, Concept of Electron spin, Larmor precession of electron orbit and Larmor's theorem, Pauli's exclusion principle, Definition of L-S coupling and j-j coupling, Spin- Orbit interaction, Spectral terms, Selection rules, Spectra of single valence electron system (sodium), Problems. **(08 hours, 08 marks)**

Unit 2: Two Valence Electron System
Introduction, Spin-spin and orbit-orbit interaction, L-S and j-j coupling schemes, Singlet triplet separations, s-p and p-d configuration in L-S coupling and j-j coupling, Lande Interval rule, Spectra of Helium, Problems**.(05 hours, 05 marks)**

Unit 3: Zeeman &Paschen Back effect
Introduction, Magnetic dipole moment, Zeeman Effect: Experimental set up, Normal and Anomalous Zeeman Effect for single valence electron system, Lande 'g' factor for two valence electron system (L-S and j-j coupling), Paschen Back effect for single valence electron system, Problems.
(07 hours, 07 marks)

Unit 4: Molecular spectra
Types of molecular spectra, Rotational spectra of rigid diatomic molecule, Rotational energy levels of rigid diatomic molecule, Vibration of atoms in a diatomic molecule, Vibrational energy levels for Diatomic molecule, Raman spectra – Experimental set up, Explanation of Stoke's and Anti-stoke's lines, Applications of Raman effect. **(10 hours, 10 marks)**
(Total: 30 hours, 30 Marks)

References:

1. Introduction to Atomic Spectra: H.E. White, McGraw Book Company, Inc.
2. Fundamental of Molecular spectroscopy: C.N. Banwell, Tata McGraw hill, 3rdedition.
3. Spectra of Diatomic Molecules: G Hertzberg, D Van Nastrand compony, Inc., New York.
4. Perspectives of Modern Physics: Arthur Beiser, McGraw Hill KogakushaLtd,Tokyo.
5. Atomic spectra and Molecular spectra: Raj kumar, Kedarnath Ramnath Prakashan.
6. Introductory Raman spectroscopy: Elsevier publication.
7. Theoretical Atomic physics (Fourth Edition): Harald Friedrich.
8. Physics of Atoms and Molecules (Second edition):B. H. Bransden& C. J.Joachain.
9. The fundamentals of Atomic and Molecular Physics: Robert L.Brooks..

Semester V: DSC-18:
PHY-MJP-304 Physics Practical Paper-VII
(Credits: 02): (30 H, 30M) (20 Internal + 30 External)

Perform any ten experiments:

1. Moment of Inertia by Bifilar suspension.
2. Y and η by Searle's method.
3. Y by Koenig's method.
4. Y by Newton's rings.
5. Searle's Goniometer.
6. Lloyd's single mirror.
7. To estimate temperature of Na-flame.
8. Measurement of resistivity by four probe method.
9. Frequency of AC/ Tuning fork by stroboscope.
10. Variation of resistance of a filament of a bulb with its temperature.
11. Determination of velocity of sound using ultrasonic Interferometer.
12. Electromagnetic Pendulum.
13. Determination of circular aperture of LASER.
14. Measurement of self-inductance of a coil by Anderson's bridge.
15. To determine the human audibility.
16. Study of I-V characteristics of solar cell.
17. Determination of fill factor and efficiency of solar cell.
18. To determine the solar constant.

Semester V: DSC-19:
PHY-MJP-305 Physics Practical Paper-VIII
(Credits: 02): (30 H, 30M) (20 Internal + 30 External)

Perform any ten of the following experiments

1. Hall Effect.
2. Analysis of XRD pattern.
3. Measurement of resistivity by two probe method.
4. Characteristics of JFET.
5. UJT characteristics.
6. UJT as relaxation oscillator.
7. Study of RC/LC filter (Low pass and High Pass)
8. Study of Hartley oscillator. (Calculation of frequency and verification of frequency from sinusoidal output waveform)
9. Measurement of self inductance using Maxwell's induction bridge.
10. Multiplexer (2 to 1 or 4 to 1) and/or De-multiplexer (1 to 2 or 1 to4).
11. To make two PCB's i) Using discrete components ii) Using IC components.
12. To study inverting and non-inverting configuration of Op amp.
13. To study of OP AMP as an adder.
14. DAC (R- 2R ladder, without OP-AMP).
15. To study reverse bias characteristics of photodiode.
16. To study characteristics of photo transistor.
17. To design and study of regulated power supply using IC723.
18. Designing and fabrication of transformer.
19. Triangular, square wave generator using OPAMP.
20. V to F converter usingIC-741.
21. V to T converter usingIC-741.
22. Study of function generator.
23. To study fixed voltage regulator using 78XX and79XX.

PHY-VSCP-306 Experimental Skills in Physics I

(Credits: 02): (30 H, 30M)(20 Internal + 30 External)

1. To identify the different equipment's in used in physics lab.
2. To study of CRO for the measurement of voltage and frequency
3. To study the calibration of Spectrometer
4. To study the function and operation of IC. (IC 555, IC 741, IC 7400, etc.)
5. To study and demonstration of various geometrical glasses.
6. To study how to draw the graphs using excel.
7. To plot the graph of distance verses time, velocity verses time by given data and write
8. To plot the graph of distance verses time, velocity verses time by given data and writethe conclusion
9. To study the principle and operation of Transformer.
10. To determine the radius of curvature of the lenses by using spherometer

PHY-MN-311: Renewable Energy Sources

(Credits: 02): (30 H, 30M) (20 Internal + 30 External)

Unit-1 Introduction (5H, 5M)

Principles of renewable energy, energy and sustainable development, fundamentals and social implications, worldwide renewable energy availability, renewable energy availability in India.

Unit-2 Solar Energy (7H, 7M)

Fundamentals, Solar Radiation, Estimation of solar radiation on horizontal and inclined surfaces, Solar radiation Measurements- Pyrheliometers, Pyrometer, Peak Sun Hours. Solar Thermal systems: Flat plate collector; Absorption and Radiation, Optimal collector tilt and orientation, Collector performance, Useful energy gain, energy losses, efficiency, selective coatings; Principle of Solar cell, Photovoltaic system for electric power generation, advantages, Disadvantages and applications of solar photovoltaic system.

Unit-3Wind Energy (10H, 10M)

Properties of wind, availability of wind energy in India, wind velocity and power from wind, major problems associated with wind power, Power in the Wind, Conversion of Wind Power: Wind Turbine, Efficiency of Wind Power Conversion: C*p*, Basic components of wind energy conversion system (WECS), Classification of WECS- Horizontal axis- single, double and muliblade system. Vertical axis- Savonius and darrieus types.

Biomass Energy: Introduction, Photosynthesis Process, Biofuels, Biomass Resources, Biomass conversion technologies-fixed dome, Urban waste to energy conversion.

Unit-4 Tidal Power and Green Energy (8H, 8M)

Tides and waves as energy suppliers and their mechanics, fundamental characteristics of tidal power, harnessing tidal energy, advantages and limitations.

Green Energy Introduction, Fuel cells: Classification of fuel cells – H_2; Operating principles, Zero energy Concepts. Benefits of hydrogen energy, hydrogen production technologies (electrolysis method only), hydrogen energy storage, applications of hydrogen energy, problem associated with hydrogen energy.

Reference Books:

1. Principles of Energy conversion, A. W. Culp Jr.,, McGraw Hill, 1996
2. Non-Convention Energy Resources, Shobh Nath Singh, Pearson, 2018
3. Non-Conventional Energy Resources, B.H. Khan, Tata McGraw-Hill Education (2006).
4. Renewable Energy Technologies: A Practical Guide for Beginners, Chetan Singh Solanki, PHI School Books (2008).
5. Fundamentals of Renewable Energy Systems Paperback – D. Mukherjee, New Age International Publisher; First edition (2011)
6. Renewable Energy Sources and Emerging Technologies, Kothari D.P. and Singal K.C., New Arrivals - PHI; 2 edition (2011)
7. Non- conventional Sources of Energy, G. D. Rai, Khanna Publishers, Delhi.
8. Solar Photovoltaics: Fundamentals, Technologies and Applications, Chetan Singh Solanki PHI; 3 edition 2015.

MNP-10 PHY-MNP-312: Lab on Renewable Energy Sources

(Credits: 02): (30 H, 30M) (20 Internal + 30 External)

1. Effect of light intensity on the output power of PV module.
2. Effect of shading on the output power of PV module.
3. Find out the start up speed and cut-in speed of wind turbine experimentally.
4. Evaluate the Tip Speed Ratio (TSR) at different wind speed.
5. Evaluate the coefficient of performance of wind turbine.
6. Draw the turbine power versus wind speed curve.
7. Draw the curve between TSR and coefficient of power.
8. Draw the power curve of turbine with respect to the rotational speed of rotor at fixed wind speed.
9. Demonstrate the power analysis at different branches of wind turbine energy system (at high frequency) with AC load only.
10. Demonstrate the power analysis at different branches of wind turbine energy system (at high frequency) with DC load only.
11. Study of Solar Box Cooker: Evaluation of first figure of merit F_1 and second figure of merit F_2
12. Evaluate overall loss coefficient (U_L) and Heat removal factor (F_R) in thermosyphonic mode of flow with fixed input parameter.
13. Evaluate thermal efficiency of the collector (η) in thermosyphonic mode of flow with fixed input parameter.
14. Evaluate overall loss coefficient (U_L) and Heat removal factor (F_R) in thermosyphonic mode of flow at different radiation level.
15. Evaluate thermal efficiency of the collector (η) in thermosyphonic mode of flow at different radiation level.
16. Evaluate overall loss coefficient (U_L), Heat removal factor (F_R) and thermal efficiency of the collector (η) in thermosyphonic mode of flow with different wind speed.
17. Evaluate thermal efficiency of the collector (η) in forced mode of flow at different flow rate and draw the curve between efficiency versus mass flow rate.
18. Evaluate overall loss coefficient (U_L), Heat removal factor (F_R) and thermal efficiency of the collector (η) in forced mode of flow at different wind speed.
19. Evaluate overall loss coefficient (U_L), Heat removal factor (F_R) and thermal efficiency of the collector (η) in forced mode of flow at different tilt angle and all other parameters are fixed.

PHY-EC-321: Nanomaterials: Introduction and Synthesis

(Credits: 02): (30 H, 30M) (20 Internal + 30 External)

Course description:

This course is aimed at introducing the fundamentals of nanomaterials and nanotechnology to Under Graduate students.

Course objectives:

This course aims to study

1) Chronological development of nanomaterials and nanotechnology
2) Basic concepts of nanomaterials
3) Different synthesis methods for nanomaterials

Course outcome:

Learner will be able to ….

1) Apply the concept and knowledge of nanomaterials and nanotechnology Physics to understand and solve the real life problems.
2) Understanding of the course will create scientific temperament.

Unit I: Introduction to the word "nano" (8 H, 8 M)

Nano and Nature, introduction to nanoscale, Nanoscopic colours (Butterfly wings), Bioluminescence (Fireflies), Tribology (Geckos Sticky feet, lotus leaf effect etc.) in nature, the development of nanoscale science: Nanotechnology timeline, pre-18^{th} Century; 19^{th} Century, 20^{th} Century, 21^{th} Century, difference between bulk materials verses nanomaterials, types of nanomaterials: 0-D (quantum dots), 1-D (quantum wires), 2-D (quantum well.), 3-D.

Unit II: Properties of nanomaterials (6 H, 6 M)

Size Effect on thermal, electrical, electronic, mechanical, optical, physical and magnetic properties of nanomaterials, surface area to volume ratio (SVR), aspect ratio, concept of quantum confinement.

Unit III: Synthesis of nanomaterials: Physical methods (6 H, 6 M)

Ball milling: Principle, construction, working, advantages and limitations.

Physical vapour deposition technique:

Resistive heating**:** Principle, construction, working, advantages and limitations.

LASER ablation: Principle, construction, working, advantages and limitations.

Unit IV: Synthesis of nanomaterials: Chemical methods (6 H, 6 M)

Sol-gel method: definition, steps involved in sol-gel method, factors affecting sol-gel method, synthesis of metal oxide nanoparticles.

Colloidal route: definition of colloid, synthesis of metal nanoparticles.

Unit V: Synthesis of nanomaterials: Biological methods (4 H, 4 M)

Introduction, synthesis using microorganisms, synthesis using plant extract, synthesis using proteins.

Reference Books:

1. Fundamentals of Nanotechnology, CRC press, by G.L. Hornyak, J.J. Moone, H.F. Tihhale, J. Dutta
2. Fundamental of Nanoscience by SulbhaKulakarni
3. Introduction to Nanoscience and Nanotechnology, G. L. Hornyak, H. F. Tibbals, J. Dutta, J. J. Moore CRC Press 2008
4. Nanotechnology: Principles and practices, 3rd Edition, Sulabha K. Kulkarni, Capital Publishing Company 2015
5. Fundamentals of Nanotechnology, G.L. Hornyak, J.J. Moone, H.F. Tihhale, J. Dutta, CRC press.
6. Nanotechnology :Technology Revolution of 21st Century by RakeshRathi, published by S.Chand.
7. Introduction to Nanoscience, Stuart Lindsay, Oxford University Press: 2010.
8. Introduction to Nanomaterials and nanotechnology by Vladimir Pokropivny, RynnoLohmus, Irina Hussainova, Alex Pokropivny and Sergey Vlassov
9. Nanomaterials by A.K. Bandyopadhyay; New Age International Publishers
10. Nanotechnology by Mark Ratner and Daniel Ratner, Pearson Education
11. Nanomaterials Chemistry by Rao C. N., A. Muller, A. K. Cheetham,, WileyVCH , 2007.

PHY-ECP-322

Lab On PHY-EC-321 Nanomaterials: Introduction and Synthesis

(Credits: 02): (30 H, 30M) (20 Internal + 30 External)

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1. Synthesis of Silver nanoparticles by using *MangiferaIndica* leaves.
2. Synthesis of Silver nanoparticles by using *MurrayaKoenigii* leaves.
3. Synthesis of Silver nanoparticles by using *AzardirectaIndica* leaves.
4. Synthesis of ZnO nanoparticles by sol-gel method.
5. Preparation of ZnO thin films by dip coating method.
6. Preparation of ZnO thin films by spin coating method.
7. Synthesis of SnO nanoparticles by sol-gel method.
8. Preparation of SnO thin films by dip coating method.
9. Preparation of SnO thin films by spin coating method.
10. Preparation of Cadmium sulphide (CdS) thin film by chemical bath deposition method.

Semester V: PHY-FP-341 Field Project

(Credits: 04): (120H, 100M) (40 Internal + 60 External)

Objectives:

- To provide students with practical exposure through direct fieldwork.
- To develop skills in data collection, analysis, and report writing.
- To bridge the gap between theoretical knowledge and real-world practice.
- To encourage problem identification and solution-oriented thinking.

Course Structure and Hour Distribution:

Methodology:

- Selection of a relevant field/project topic.
- Fieldwork through visits, interviews, surveys, or observation.
- Collection of primary and secondary data.
- Data interpretation using basic analytical tools.
- Preparation of a structured field project report.
- Oral presentation of findings.

Field Project Report Guidelines:

- Introduction: Background, objectives, scope.
- Methodology: Tools and techniques used.
- Data Presentation: Tables, charts, and figures.
- Analysis: Interpretation of field data.
- Findings & Suggestions: Based on analysis.
- Conclusion: Summary and recommendations.
- Annexures: Questionnaire, references, etc.
- Length: Minimum 30–40 pages.

Assessment Scheme (100 Marks):

Learning Outcomes:

- Ability to plan and execute field-based research.
- Skills in data gathering, analysis, and reporting.
- Improved communication through presentations.
- Understanding of real-life challenges in relevant fields.
- Capacity to provide practical recommendations.

Semester VI: DSC-20:
PHY-MJ-351 Quantum Mechanics
(Credits: 02): (30 H, 30M (20 Internal + 30 External)

Course description:

This course is aimed at introducing the fundamentals of Quantum Mechanics to Under Graduate students.

Course objectives:

1. To impart knowledge of basic concepts in Quantum Mechanics.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.

Course outcome:

Learner will be able to ….

1. Apply the concept and use of knowledge of Quantum Mechanics to real life problems.
2. Understanding of the course will create scientific temperament.

Unit 1: The Schrodinger Equation

Introduction to Quantum Mechanics, Wave function and its Physical interpretation, normalized and orthogonal wave functions, Requirements of wave function, Formulation of time dependent and time independent Schrödinger equation (Steady state equation), Solution of Schrodinger's equations, Energy eigenvalues and eigen functions, Expectation value, , Postulates of Quantum Mechanics. (Ref: 1, 2 and 9)

(10H, 10M)

Unit 2: Applications of Schrödinger steady state equation

Particle in a one dimensional rigid box (derivation of energy eigenvalues and eigen functions), Linear Simple Harmonic oscillator (derivation of energy eigenvalues and eigen functions) (1D). (Ref: 2, 6 and 7)

(10H, 10M)

Unit 4: Operators in Quantum Mechanics

Operators and linear operators, Position, Momentum operator, angular momentum operator, and total energy operator (Hamiltonian), Commutator bracket, Commutator algebra, Commutator brackets using position, momentum and angular momentum operator, Commutation relations and Hamiltonian operator; Commutation rules for components of orbital angular momentum; Commutation relations of L^2 with components of orbital angular momentum; Commutation relation of components of orbital angular momentum with position operator

(10H, 10M)

(Total: 30 Hours, 30 Marks)

References:

1. Perspectives of Modern Physics: Arthur Beiser.
2. Advanced Quantum Mechanics: Satya Prakash, Kedarnath Ram Nath, Meerut
3. Quantum Mechanics: Gupta, Kumar, Sharma. Sultan Chand &Sons
4. Quantum Mechanics: Chatwal and Anand. Himalaya Publ.Co.
5. Quantum Mechanics: L. I. Schiff.
6. Quantum Mechanics: Powell and Crasemann, Addison-Wesley Pub. Co.
7. Introduction to Quantum Mechanics: D. Griffiths Published by Prentice Hall,
8. Quantum Physics: 2nd Ed. H.C. Verma, Surya Publications, Ghaziabad (UP),2009.
9. Quantum Mechanics: Concepts and Applications, Nouredine Zettili, Wiley Publications.

Semester VI: (DSC): Physics paper III
DSC-21: PHY-MJ-352 Elements of Nuclear Physics
(Credits: 02) :(30 Hours 30 Marks)

Course description:

This course is aimed at introducing the fundamentals of Nuclear Physics to Under Graduate students.

Course objectives:

1. To impart knowledge of basic concepts in Nuclear Physics.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.

Course outcome:

Learner will be able to ….

1. Apply the concept and use of knowledge of Nuclear Physics to understand and solve the real life problems.
2. Understanding of the course will create scientific temperament.

Unit 1: Nucleus and Nuclear Forces

Nuclear composition: Constituents, charge, size, density, atomic mass of the nucleus, nuclear magnetic moment, parity (even and odd).Mass defect, binding energy, nuclear stability, packing fraction, classification of nuclei. Nuclear forces: Features, saturation, short-range nature.

(6H, 06M)

Unit 2: Radioactivity

Law of radioactive decay, half-life, mean life, specific activity, Partial radioactive decay, successive disintegration, Applications: Agricultural, biological, medical, and industrial.

(6H, 06M)

Unit 3: Nuclear Models

Types of nuclear models *(list only)*.Single Particle Shell Model: Introduction, assumptions, evidence of shell model, nuclear spin & parities, limitations. Liquid Drop Model: Introduction, assumptions.

(6H, 06M)

Unit 4: Nuclear Energy

Nuclear Fission: Explanation using the liquid drop model, estimation of energy from fission, Nuclear chain reaction, power from fission, applications. Nuclear Fusion: Principles, energy considerations. Nuclear Reactors: Basic principles, classification. **(8H, 08M)**

Unit 5: Nuclear Detectors and Accelerators

Nuclear Detectors: Types, Geiger-Mueller counter scintillation counter. Particle Accelerators: Classification, working of cyclotron.

(4H, 4M)

(Total: 30 Hours, 30 Marks)

References:

1. The atomic Nucleus: R D Evans, McGraw Hill Book Company.
2. Nuclear Physics: D C Tayal, Himalaya Publishing House, Bombay.
3. Nuclear Physics: Irving Kaplan, Narosa Publishing House, NewDelhi.
4. Basic Nuclear Physics and Cosmic Rays: B. N. Srivastava, Pragati Prakashan, Meerut.
5. Concepts of Modern Physics – Arthur Beiser (5thEdition).
6. Atomic Physics: J.B.Rajam.
7. Introduction to Nuclear Physics: H.A. Enge (Addition Wesely Co.)

Introduction to Indian Knowledge System
PHY-IKS- 353: IKS in Physics
(Credits: 02) :(30 hours, 30 Marks)

1) Creating awareness amongst the youths about the true history and rich culture of the country.
2) Understanding the scientific value of the traditional knowledge of Bhārata.
3) Promoting the youths to do research in the various fields of Bhartiya knowledge system;
4) Converting the Bhartiya wisdom into the applied aspect of the modern scientific paradigm

Unit 1: Introduction to Indian Knowledge System in Physics (06M, 06H)

Definition and scope of Indian knowledge systems in the context of physics, Historical Overview of ancient Indian contributions to science, Key texts and scholars in Indian Physics.

Unit.2 Indian Scientist in Physics: (06M, 06H)

Bhaskaracharya, Aryabhatta, Acharya Kanada, Sir C. V. Raman, SatyendraNath Bose, Homi Jahangir Bhabha, Subrahmanyan Chandrasekhar, Vikram Ambalal Sarabhai, MeghnadSaha.

Unit 3: Vedic Physics and Philosophy (06M, 06H)

Study of the philosophical and metaphysical foundations of Indian physics, Concepts likePrakriti (nature), Purusha (consciousness), and their relevance to physics, Vedic cosmology and its connection to modern cosmological theories.

Unit 4: Classical Indian Physics (06M, 06H)

Detailed exploration of classical Indian physics principles, Theory of five elements (Panchabhuta) and the concept of ether (Akasha),Laws of Motion and Theory of Gravitation, Concepts like sound (Nada), light (Prakasha), and heat (Tejas) in Indian physics.

Unit 5: Indian Astronomy (06H, 06H)

The universe The Nine Planets (Navagrahas), Age of Earth, Duration of Year, Eclipses of the Sun and the Moon, Distance of Sun and Moon from the Earth, Diameter and Duration of Revolution of Planets around the Sun, Division of Day

Text books:

1. Textbook on The Knowledge System of Bhārata by Bhag Chand Chauhan,
2. Histrory of Science in India Volume-1, Part-I, Part-II, Volume VIII,
bySibajiRaha, et al. National Academy of Sciences, India and The Ramkrishan Mission Institute of Culture, Kolkata (2014).

Reference Books:

1. Pride of India- A Glimpse of India's Scientific Heritage edited by Pradeep Kohle et al. SamskritBharati (2006).
2. Vedic Physics by KeshavDevVerma, MotilalBanarsidass Publishers (2012).
3. India's Glorious Scientific Tradition by Suresh Soni, Ocean Books Pvt. Ltd. (2010)
4) Basham A.L. , A Wonder that was India, shivlal Agrawal & Co. , 2006.
5) Zaa D. N. Shrimali K.M, Ancient India, Vishvavidyalay Publication, Delhi, 2012 . (Hindi)
6) Dhavlikar M. K., Puratatvavidya , Continental , Pune, 2010.

Websites:

1.https://magnificentmaharashtra.wordpress.com/2015/01/16/bhaskaracharyas-law-of-gravity discovered1200-years-before-newton/(accessed on 02/ 12/ 2024).
2.https://pparihar.com/2017/05/22/modern-inventions-stolen-from-the-vedas/(accessed 01/12/2024).
3.Vaishesika Sutras by Kanada describe Laws of Motion (accessed on 1. 12.2024).
4.https://www.ancient-origins.net/.../ancient-indian-sages-advanced-knowledge-science-t... (accessed on 02. 12.2024).

Semester VI: DSC-23:
PHY-MJP-354 Physics Practical Paper-IX
(Credits: 02): (30 H, 30 M) (20 Internal + 30 External)

Perform any TEN experiments:

1. Surface tension by Quinke's method.
2. Surface tension by soap bubble method.
3. Characteristics of G.M. counter.
4. Diffraction by straight edge/cylindrical obstacle.
5. e/m using Thomson's method.
6. Viscosity by rotating cylinder method.
7. Determination of 'g' by conical pendulum.
8. Study of oscillatory charge and discharge through an inductance and resistance.
9. To determine value of Boltzmann Constant using V-I characteristics of P-N diode.
10. To determine work function of material of cathode using photocell.
11. To determine value of Plank's constant using LEDS of at least four different colours.
12. To study intensity response of photocell and verify inverse square law of radiations.
13. To measure the numerical aperture of an optical fiber.
14. Study of bending loss in optical fiber.
15. Study of I-V characteristics of photocell.
16. Determination of Plank's constant of Photocell.
17. Study of Solar still for water distillation.
18. Study of box type Solar cooker.

Semester VI: DSC-24:

PHY-MJP-355 Physics Practical Paper-X

(Credits: 02): (30 H, 30 M) (20 Internal + 30 External)

Perform any ten experiments:

1. Determination of curie temperature of Ferrite.
2. Determination of specific heat of graphite at different temperature
3. To study characteristics of thermisters.
4. Determination of thermoelectric power.
5. Study of Astable Multivibrator using IC555.
6. Binary weighted DAC (R-2R ladder) using OP-AMP.
7. Determination of Core losses in transformers.
8. To study of clocked RS flip flop using NAND gates.
9. Study of IC 7490 as mod 2, mod 5 and mod 10counter.
10. To study RC coupled Single stage transistor amplifier. (Voltage gain, Frequency response)
11. To study characteristics of LDR.
12. Study of P. A. system (series and parallel connection of two speakers) and measurement of equivalence resistance.
13. Use of C.R.O as a measurement tool for different electrical parameters (Frequency, a.c./d.c.voltage,pulseheight,pulsewidth,risetimeandfalltime).
14. Use of thermocouple for measurement of temperature.
15. Study of OP AMP a subtractor.
16. Study of OP- AMP as a differentiator.
17. Study of OP- AMP as an integrator.
18. Displacement measurement using LVDT.
19. Frequency response of loudspeaker (twitter, woofer, mid-range).
20. Study of E.C.G.
21. Thermister as a thermometer using IC741.
22. Half wave precision rectifier using OPAMP.
23. Full wave precision rectifier using OPAMP.

PHY-VSCP-356
Experimental Skills in Physics II
(Credits: 02): (30 H, 30M) (20 Internal + 30 External)

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1. To measurement of 'Q' factor using LCR circuit
2. To measurement of rise, fall and delay times using a CRO
3. To study Characteristics of Photodiode and measure its responsivity.
4. To measure the Power and Energy of different LEDs
5. To study how soldering and de-soldering of LED in done. (Hands on Training)
6. To check LEDs in series and parallel circuit. (Hands on Training)
7. To demonstrate the process of soldering if loose, de-soldered wires and connections are found
8. To demonstrate basic knowledge of assembly of products such as spotlight, LED bulb and LED tube light.
9. To measurement of Led Light output using a Photodiode.
10. To study the wavelength characteristics of LED for different 3 colors and measure it.
11. To study the properties of LED and how they can combined in the 7-segment display.

Semester VI: PHY-MN-361 Digital Electronics-I

(Credits: 02): (30 H, 30M) (20 Internal + 30 External)

Course description:

This course is aimed at introducing the fundamentals of Advanced electronics -I to Under Graduate students.

Course objectives:

1. To impart knowledge of basic concepts in digital electronics -I.
2. To provide the knowledge and methodology necessary for solving problems in physics.
3. The course also involves the related experiments based on thetheory.

Course outcome:

Learner will be able to ….

1. Apply the concept and use of knowledge of digital electronics -I to real lifeproblems.
2. Understanding of the course will create scientific temperament.

Unit 1: Digital Electronics:

Binary Numbers, Decimal to Binary and Binary to Decimal Conversion, Binary Addition, Binary Subtraction using 2's Complement Method, AND, OR and NOT Gates (Realization using Diodes and Transistor), NAND and NOR Gates Universal Gates, XOR and XNOR Gates,

De Morgan's Theorems, Boolean Laws, Simplification of Logic Circuit using Boolean Algebra, Half Adders and Full Adders and Subtractors,4-bitbinaryAdder-Subtractor.**(08H, 08M**)

Unit 2: Transistor biasing and Transistor amplifiers:

Need of biasing, Different methods of biasing (only list), Voltage Divider bias method in detail, Single stage RC coupled Common emitter amplifier: Working, voltage gain, frequency response and bandwidth, Definition of Voltage amplifier and Power amplifier, Class A, B, C and AB power amplifiers (only load line diagram and explanation) and application list of each type. **(09H, 09M)**

Unit 3: Transistorized Sinusoidal Oscillators:

Types of feedbacks, Barkhausen Criterion, Oscillatory circuit (tank circuit), Types of Oscillators (List only), Hartley oscillator, RC phase shift Oscillator. **(04H, 05M)**

Unit 4: Semiconductor switching devices:

FET: Types (n-channel and p-channel), Constructional detail, electronic symbol, working principle and I-V Characteristics, FET parameters, Introduction to MOSFET, Applications: FET as a VVR, FET as an amplifier.

UJT: Constructional detail, Equivalent circuit, symbol, working principle and I-V Characteristics, Applications: UJT as a switch, UJT as a relaxation oscillator.**(09H, 08M)**

References:

1. Principles of Electronics – V. K. Mehta, S. Chand Publications, NewDelhi.
2. Basic Electronics: B. L. Theraja, S. Chand Publications, NewDelhi.
3. Digital Principles and Applications – Malvino and Leach, McGraw-HillPublication.
4. Electronic Principles – A. P. Malvino, Mc-Graw-Hill PublishingHouse.
5. Modern Digital Electronics – R. P. Jain, Tata McGraw-Hill Pvt. Ltd., NewDelhi.
6. Integrated Circuits - K. R. Botkar, Khanna Publishers(2004).
7. Electronic fundamentals and applications – J. D. Ryder, Prentice Hall 4thEdition.
8. Electronic Devices and Circuits – Allen Mottershead, Good year publishingCompany

PHY-MNP-362 Lab on Digital electronics-I

(Credits: 02): (30 H, 30M) (20 Internal + 30 External)

1. Introduction to Digital Laboratory equipments & IC's.
2. To study basic logic gates and verify their truth tables.
3. Verification of De Morgan's Theorems (using ICs).
4. To study the characteristics of Light Emitting Diode (LED).
5. Experimental verification of NAND gate as a universal building block.
6. Experimental verification of NOR gate as a universal building block.
7. Study of seven segment display.
8. Implementation of the given Boolean function using logic gates in both SOP and POS forms.
9. Simplification of Logic circuits using laws and theorems of Boolean algebra.
10. Construction AND of gate using diode and resisters.
11. Study of Astable Multivibrator using Transistor.
12. Study of Half Adder using basic gates.

DSE-1

PHY-EC-371 Nanomaterials: Characterization and Applications-II

(Credits: 02): (30 H, 30M) (20 Internal + 30 External)

Course description:

This course is aimed at introducing the fundamentals of nanomaterials and nanotechnology to Under Graduate students.

Course objectives:

This course aims to study

1) Learning of advanced characterization tools for analysis of nanostructured materials.
2) Applications of nanomaterials in agriculture, energy storage and medicine.

Course Outcomes:

After completion of this course student will able to

1. Understand different analytical techniques to characterize the nanomaterials.
2. Learn about applications of nanomaterials in different areas.

Unit I: Characterization techniques for nanomaterials I (6 M, 6 H)

XRD: Working Principle, Block diagram of instrument, Function

UV-Visible Spectroscopy: Working Principle, Block diagram of instrument, Function

FTIR Spectroscopy: Working Principle, Block diagram of instrument, Function

Unit II: Characterization techniques for nanomaterials II (6 M, 6 H)

SEM: Working Principle, Block diagram of instrument, Function and role of each block, Interaction of electron beam, Output form and its analysis, limitations, applications.

TEM: Construction, Working Principle, Image formation, Different Operational Modes: Bright field and Dark field imaging, High Resolution (HR) / Lattice mapping imaging,

Unit III: Applications of nanomaterials I (6 M, 6 H)

Nanotechnology in Agriculture: Nano-fertilizers, Nano-pesticides, Nano-sensors, Nano-seed germination, properties of nanomaterials in agriculture, limitations, policy actions and options.

Unit IV: Applications of nanomaterials II (6 M, 6 H)

Nanomaterials in Energy Storage: Nano-electrochemical systems, nanomaterials for rechargeable batteries, nanomaterials for fuel cells, carbon material for energy storage.

Unit V: Applications of nanomaterials III (6 M, 6 H)

Introduction to Nano medicine; Applications of Nanotechnology in Medicine, Challenges of Nanotechnology in Medicine, Nano toxicity and Safety Concerns.

References:

1. Handbook of Microscopy, Applications in Materials Science, Solid State Physics and Chemistry, Edited by D. van Dyck, J. van Landuyt and G. van Tendeloo VCH,UK.
2. Handbook of Instrumental Techniques for Analytical Chemistry, Edited by Frank A. Settle, Printice Hall, PTR, New Jersey, USA.
3. Instrumental Methods of Analysis, by Willard, Merritt, Dean and Settle, CBS Publishers & Distributors; 7th edition (2004)
4. Encyclopedia of Materials Characterization by C. Richard Brundle Charles A. Evans, Jr.ShaunWilson ,Butterworth-Heinemann, 1992.
5. Nanostructures and Nanomaterials, synthesis, properties and applications by Guozhong Cao, Imperial College Press, 2004.
6. Linden, Hand book of Batteries and fuel cells, McGraw Hill, (1984).
7. Hoogers, Fuel cell technology handbook. CRC Press, (2003).
8. Handbook of fuel cells: Fuel cell technology and applications, Wiley, CRC Press, (2003).
9. Nanotechnology in agriculture and food production by Jennifer Kuzma and Peter VerHage,, Woodrow Wilson International, 2006.
10. Bionanotechnology by David S Goodsell, John Wiley & Sons, 2004.
11. Nanobiomaterials Handbook by Balaji Sitharaman, Taylor & Francis Group, 2011.

PHY-ECP-372
Laboratory on Nanomaterials : Characterization and Applications-II

(Credits: 02): (30 H, 30M) (20 Internal + 30 External)

1. To study the working of FTIR spectroscopy.
2. Analysis of Raman Spectra of given metal oxide.
3. To study of Characterization technique Scanning Electron Microscopy (SEM).
4. To study of Characterization technique Transmission Electron Microscopy (TEM).
5. Study of absorption spectrum of $FeCl_3$ solution
6. Measurement of thickness of thin film using weight difference method.
7. Study of IR spectra of given material.
8. Study of TGA curve of given material.
9. To determine the grain size of given material from given XRD pattern
10. Analysis of Surface Morphology using SEM/FESEM.
11. Analysis of structural Morphology using TEM/HRTEM.
12. IV characteristics of pure ZnO thick films.
13. Determination of band gap of given material from UV-Visible spectra.

Semester VI: PHY-OJT-391
On Job Training/Internship

(Credits: 04): (120H, 100M) (40 Internal + 60 External))

Objective:

- To provide students with practical exposure to real workplace environments.
- To develop hands-on skills in their area of study.
- To integrate theoretical knowledge with professional practice.
- To build communication, teamwork, and problem-solving abilities.

Mode:

Internship or training in a relevant industry, organization, institution, or social setting.

Supervision by internal faculty and external industry mentor.

Course Structure:

OJT Deliverables:

1. Training Diary:

Daily/Weekly log of work done, skills learned, and observations.

2. OJT Report:

Introduction of organization

Objectives of training

Description of tasks performed

Skills acquired