BANGALORE UNIVERSITY

Department of Physics

Jnana Bharathi Campus, Bangalore – 560 056

V and VI Semester

B.Sc., PHYSICS SYLLABUS

From 2013-14 onwards

BANGALORE UNIVERSITY

Syllabus, Scheme of Instruction & Examination for B.Sc., Physics

Semester Scheme (from 2011- 12)

Serial Number	*Paper Number*	*Teaching hours per week*	*Examination duration*	*Maximum marks* Final exam	*Maximum Total marks*
01	PHY 101	4	3 hours	70	100
02	PHY 102	3	3 hours	30	
03	PHY 201	4	3 hours	70	100
04	PHY 202	3	3 hours	30	
05	PHY 301	4	3 hours	70	100
06	PHY 302	3	3 hours	30	
07	PHY 401	4	3 hours	70	100
08	PHY 402	3	3 hours	30	
09	PHY501	3	3 hours	70	100
10	PHY502	3	3 hours	30	
11	PHY503	3	3 hours	70	100
12	PHY504	3	3 hours	30	
13	PHY601	3	3 hours	70	100
14	PHY602	3	3 hours	30	
15	PHY603	3	3 hours	70	100
16	PHY604	3	3 hours	30	
				Grand total	**800**

Note-I:

- The paper number is a three digit number with ' **0** ' in the middle
- The digit to the left of ' **0** ' indicates the semester number
- Odd number to the right of ' **0** ' indicates a theory paper
- Even number to the right of ' **0** ' indicates a practical paper

Note-II:

The marks distribution for the final practical examination is as follows:

1. Writing formula, Explanation, Figure/circuit diagram — 05 Marks
2. Setting up of the experiment & entering the observations in the tabular column. — 15 Marks
3. Calculation / Graph, Results with units — 05 Marks
4. Class Records (to be valued at the time of practical examination) — 05 Marks

Total for the practical examination **30** marks

Note-III:

*A minimum of **EIGHT** (8) experiments must be performed in each practical paper*

Syllabus for V Sem. B.Sc. (Physics)

PHY 501: QUANTUM STATISTICAL PHYSICS, QUANTUM MECHANICS-I AND II

Unit-1: Statistical Physics

Maxwell – Boltzmann distribution function (with derivation) **1 hour**

Bose-Einstein Statistics

B-E distribution law (with derivation), Bose-Einstein condensation properties of liquid He (qualitative description). Radiation as photon gas. Bose's derivation of Planck's law, Rayleigh-Jeans law, Wein's law, Thermodynamic functions of photon gas. Specific Heat capacity of metals. **9 hours**

Fermi – Dirac Statistics

Fermi-Dirac distribution function (with derivation), Fermi sphere and Fermi energy, Fermi gas, Electronic heat capacity in metals.

Comparison of Maxwell – Boltzmann, Bose – Einstein and Fermi – Dirac distribution functions. **5 hours**

Unit-2: Quantum Mechanics-I

Introduction to quantum mechanics : Planck's quantum theory, failure of classical physics to explain the phenomena such as stability of atom, atomic spectra, black body radiation, photo electric effect, Compton effect and specific heat of solids . Explanation of the above effects on the basis of quantum mechanics. **5 hours**

de Broglie's hypothesis of matter waves, Thomson's experiment, Davisson and Germer's experiment – normal incidence method, concepts of packets for quantum particle, group velocity and phase velocity, relation between particle velocity and group velocity. Heisenberg's uncertainty principle - different forms, Gamma ray microscope experiment, applications **10 hours**

Unit-3: Quantum mechanics-II

The concept of wave function, physical significance of wave function. Development of time dependent and time independent Schrodinger's wave equation. Max Born's interpretation of the wave function. Normalization and expectation values, Quantum mechanical operators, Eigen values and Eigen functions. Applications of Schrodinger's equation – free particle, particle in one dimensional box- derivation of Eigen values and Eigen function – extension to three dimensional box; Development of Schrodinger's equation for One dimensional Linear harmonic oscillator, Rigid rotator, Hydrogen atom – mention of Eigen function and Eigen value for ground state. **15 hours**

References :

1. Quantum Mechanics, ***B.H. Bransden and C.J. Joachain***, 2nd Edition, Pearson Education (2004)
2. Introduction to Quantum Mechanics, ***David J. Griffiths***, 2nd Edition, Pearson Education ,(2005)
3. Modern Quantum Mechanics, ***J.J. Sakurai***, Pearson Education, (2000)
4. Principles of Quantum Mechanics, ***Ghatak and Lokanathan***, Macmillan, (2004)
5. Statistical Mechanics, An Introduction, **Evelyn Guha**, Narosa (2008)
6. Statistical Mechanics, ***R.K.Pathria***, 2nd edition, Pergamon Press (1972)
7. Statistical and Thermal physics, ***F.Reif***, McGraw Hill International(1985)
8. Statistical Mechanics, ***K.Huang***, Wiley Eastern Limited, New Delhi (1975)

PHY-502: PRACTICAL PHYSICS V (A)

1. Analysis of X-ray diffraction pattern obtained by powder method to determine properties of crystals.
2. Determination of Fermi energy of a metal.
3. Determination of thermal conductivity of a metal by Forbe's method.
4. Measurement of heat capacity of metals.
5. Characteristics of a photo cell-determination of stopping potential.
6. Determination of Planck's constant.
7. Characteristics and spectral response (selenium photocell)
8. Hysteresis loop for iron and finding energy loss per cycle
9. Applications of CRO in the (a) study of Lissajous figures (b) calculation of rms voltage (c) calculation of frequency of AC.
10. Regulated power supply (using zener diode).
11. Determination of transistor h-parameters.
12. Frequency response of a CE amplifier.
13. Transistor as a switch and active device.
14. Construction of RFO or AFO - using transistor
15. Emitter follower

Note: A minimum of EIGHT experiments must be performed.

References :

1. Worsnop and Flint , Advanced practical physics for students, Asia Pub.(1979)
2. Singh and Chauhan, Advanced practical physics, 2 vols., Pragati prakashan, (1976)
3. Misra and Misra, Physics Lab. Manual, South Asian publishers (2000)
4. Gupta and Kumar, Practcal physics, Pragati prakashan, (1976)
5. Ramalingom & Raghuopalan : A Lab. Course in Electronics
6. Bharagav et al : Electronics, TTI

PHY- 503: ASTROPHYSICS, SOLID STATE PHYSICS AND SEMICONDUCTOR PHYSICS

Unit-1: Astrophysics

Parallax and distance: Helio-centric parallax, Definition of parsec (pc), Astronomical unit (AU), light year (ly) and their relations.

Luminosity of stars: Apparent brightness, Apparent magnitude - scale of Hipparchus. Absolute magnitude - distance - modulus relationship. Distinction between visual and bolometric magnitudes, Radius of a star. **3 hours**

Stellar classification: Pickering classification and Yerke's luminosity classification. H-R diagram, Main sequence stars and their general characteristics.

Gravitational potential energy or self energy of a star based on the linear density model, Statement and explanation of Virial theorem.

Surface or effective temperature and color of a star : Wien's displacement law. Expressions for - average temperature, core temperature, hydrostatic equilibrium, core pressure of a star based on the linear density model of a star. Photon diffusion time (qualitative), Mass – Luminosity relationship and expression for lifetime of a star. **7 hours**

Evolution of stars: Stages of star formation (GMC – Protostar- T-Tauri) and main sequence evolution, White dwarfs, Pulsars, Neutron stars and Black holes, Variable stars, Supernova explosion- its types, Chandrasekhar limit. Event horizon, singularity and Schwarzchild's radius (qualitative) **5 hours**

Unit-2: Solid State Physics

Crystal systems and X-rays: Crystal systems-Bravais lattice; Miller indices– Spacing between lattice planes of cubic crystals, Continuous and characteristic X-ray spectra; Moseley's law, Scattering of X-rays - Compton effect, Bragg's law. **4 hours**

Free electron theory of metals : Electrical conductivity- classical theory (Drude-Lorentz model) ; Thermal conductivity; Wiedemann - Franz's law; Density of states for free electrons; Fermi-Dirac distribution function and Fermi energy; Expression for Fermi energy and Kinetic energy at absolute zero. Hall Effect in metals **5 hours**

Band theory of solids: Elementary ideas regarding formation of energy bands; Bloch theorem; One dimensional Kroning-Penney model; Effective mass; Energy gap. **4 hours**

Superconductivity : Introduction – Experimental facts – Zero resistivity – The critical field – The critical current density – Meissner effect ,Type I and type II superconductors– BCS Theory (qualitative). **2 hours**

Unit-3: Semiconductor Physics

Semiconductors: Distinction between metals, semiconductors and insulators based on band theory. Intrinsic semiconductors - concept of holes – effective mass - expression for carrier concentration and electrical conductivity – extrinsic semiconductors – impurity states in energy band diagram and the Fermi level.

Semiconductor devices: Formation of P-N junction, depletion region, Biased P-N junction, variation of width of the depletion region, drift and diffusion current –expression for diode current. **6 hours**

Special Diodes: Zener diode – characteristics and its use as a voltage regulator. Photo diodes, Solar cells and LED (principle, working and applications). **4 hours**

Transistors: Transistor action, Characteristics (CE mode), Biasing, Load line analysis -Transistor as an amplifier(CE mode). h-parameters **5 hours**

References :

1. Astronomy : Fundamentals and Frontiers – **Jastrow & Thompson**
2. Chandrashekhar and his limit – **G. Venkataraman**
3. An introduction to Astrophysics – **Baidyanath Basu**
4. Astrophysics Concepts, ***M. Herwit***: John Wiley, 1990.
5. Astrophysics. ***Krishnaswamy*** (ed)
6. Introduction to solid State Physics, ***Charles Kittel***, VII edition, 1996.
7. Solid State Physics- **A J Dekker**, MacMillan India Ltd, (2000)
8. Elementary Solid State Physic, **J P Srivastava**,PHI,(2008)
9. Essential of crystallography, **M A Wahab**, Narosa Publications (2009)
10. Solid State Physics-**F W Ashcroft and A D Mermin**-Saunders College (1976)
11. Solid State Physics-**S O Pillai**-New Age Int. Publishers (2001)

PHY –504: Practical Physics V (B)

1. Parallax Method – Distance of objects using trigonometric parallax.
2. HR Diagram & the physical properties of stars.
3. Analysis of stellar spectra.
4. Determination of temperature of a star (artificial) using filters.
5. Analysis of sunspot photographs & solar rotation period.
6. Mass luminosity curve – Estimation of mass of a star.
7. Mass of binary stars.
8. Resistivity of a material by four probe method.
9. Semiconductor temperature sensor.
10. Temperature coefficient of resistance and energy gap of thermistor.
11. LED characteristics and spectral response.
12. LDR characteristics – dark resistance – saturation resistance.
13. Solar cell characteristics – Open circuit voltage – short circuit current – efficiency.
14. Study of Hall effect in a metal.
15. Characteristics of LASER diode.
16. Spectral response of a photodiode and its I – V characteristics.

Note: A minimum of EIGHT experiments must be performed.

References :

1. IGNOU : Practical Physics Manual
2. Saraf : Experiment in Physics
3. S.P. Singh : Advanced Practical Physics
4. Melissons : Experiments in Modern Physics
5. Misra and Misra, Physics Lab. Manual, South Asian publishers, 2000
6. Gupta and Kumar, Practcal physics, Pragati prakashan, 1976
7. Ramalingom & Raghuopalan : A Lab. Course in Electronics
8. Bharagav et al : Electronics, TTI

Syllabus for VI Sem. B.Sc. (Physics)

PHY- 601: Atomic and Molecular Physics, Nuclear Physics and Material Science

Unit-1: Atomic and Molecular Physics

Vector Model of the Atom : Review of Bohr's theory of hydrogen atom, Sommerfeld's modification of the Bohr atomic model (qualitative). Spatial quantization and spinning electron. Different quantum numbers associated with the vector atom model, Spectral terms and their notations, Selection rules, Coupling schemes(*l*-s and j-j coupling in multi electron systems), Pauli's Exclusion Principle, Expression for maximum number of electrons in an orbit. Spectra of alkali elements (sodium D-line), Larmor precession, Bohr magneton, Stern-Gerlach Experiment. Zeeman Effect- Experimental study, theory of normal and anomalous Zeeman effect based on quantum theory. **10 hours**

Molecular Physics: Pure rotational motion, Spectrum and selection rules; Vibrational motion, vibrational spectrum and selection rules; Rotation-Vibration spectrum; Scattering of light-Tyndall scattering, Rayleigh scattering and Raman scattering. Experimental study of Raman effect, Quantum theory of Raman effect - Applications. **5 hours**

Unit-2: Nuclear Physics

Alpha particle scattering: Rutherford's theory of alpha scattering (assuming the path to be hyperbolic).

Alpha decay: Gamow's theory of alpha decay, Q-value of alpha decay, Exact energy of alpha particle emitted, characteristics of alpha spectrum. Geiger- Nuttal law.

Beta decay : Types of beta decay (electron, positron decay and electron capture). Characteristics of beta spectrum and Pauli's neutrino hypothesis. **8 hours**

Detectors : Variation of ionization current with applied voltage in a gas counter, GM Counter. **2 hours**

Particle accelerators: Cyclotron, Electron Synchrotron. **2 hours**

Nuclear reactions: Types of Nuclear reactions. Conservation laws. Expression for Q value of a nuclear reaction - Endoergic and Exoergic reactions, threshold energy. **3 hours**

Unit-3: Material Science

Nanomaterials : Synthesis techniques(Top down & bottom up)- Electron confinement-Size effect-Surface to volume ratio; distinction between nanomaterials and bulk materials in terms of energy band. Distinct properties of nano materials. Classification of Nanosystems - quantum dots, nanowires and nanofilms. Multilayered materials- Graphene, Fullerene, Carbon Nano Tube (CNT), Mention of applications of nanomaterials. **5 hours**

Dielectrics : Static dielectric constant, polarizability (electronic, ionic and orientation), calculation of Lorentz field (derivation), Clausius-Mosotti equation (derivation), dielectric breakdown, electrostriction (qualitative), electrets. Piezo electric effect, cause, examples and applications. **5 hours**

Liquid Crystals : Classification-Thermotropic and lyotropic. Properties - anisotropy in dielectric constant, electrical conductivity, magnetic susceptibility, refractive index and elasticity. Applications: construction and operation of twisted nematic display and thermography. **5 hours**

References :

1. Concepts of Modern Physics, **Beiser** 3rd edition, Student edition, New Delhi (1981).
2. Introduction to Atomic Physics – **H.E. White**
3. Introduction to Modern Physics – **H.S. Mani, G.K. Mehta**-West Press (1989).
4. Principles of Modern Physics, **A.P. French**, John Wiley, London (1958).
5. Modern Physics - **S.N. Ghosal**, Part 1 and 2 S. Chand and Company (1996).
6. Physics of the Atom, **Wehr et. al**. McGraw Hill
7. Atomic and Nuclear Physics, **S. N. Ghoshal**: Vol. II. (2000).
8. Alpha, beta and gamma spectroscopy, **K. Seighbahn**: Vol. I and II, John Wiley (1967)
9. N. Rudraiah (Ed) : Modelling of Nano and smart materials
10. Introduction to solid State Physics, ***Charles Kittel***, VII edition(1996).
11. Solid State Physics- **A. J. Dekker**, MacMillan India Ltd. (2000).
12. Elementary Solid State Physics, **J. P. Srivastava**,PHI (2008).
13. Modern physics, **Murugeshan et al**.
14. Nano materials, **K. P. Bandopadhyay**.
15. Nanocrystals, **C. N. Rao, P. John Thomas**.
16. Nanotubes and wires, **C. N. Rao, A. Govindaraj**.

PHY- 602: PRACTICAL PHYSICS VI (A)

1. Study of hydrogen spectrum.
2. Sommerfeld's fine structure constant determination.
3. Determination of e/m by Thomson's method.
4. Characteristics of GM counter.
5. Verification of inverse square law using GM counter (with a radioactive source).
6. Determination of mass absorption coefficient of gamma rays.
7. Determination of half-life of K^{40}.
8. Millikan's Oil drop experiment
9. Determination of phase transition temperature of liquid crystal and Identification of mesophases.
10. Analysis of band spectrum of PN molecule.
11. Analysis of rotational spectrum of nitrogen.
12. Analysis of rotational vibrational spectrum of a diatomic molecule (HBr).
13. Absorption spectrum of $KMnO_4$.
14. Determination of dielectric constant.
15. Determination of dipole moment of organic liquid

Note: A minimum of EIGHT(8) experiments must be performed.

References:

1. IGNOU : Practical Physics Manual
2. Saraf : Experiment in Physics
3. S.P. Singh : Advanced Practical Physics
4. Melissons : Experiments in Modern Physics
5. Misra and Misra, Physics Lab. Manual, South Asian publishers, 2000
6. Gupta and Kumar, Practcal physics, Pragati prakashan, 1976

PHY-603: ATMOSPHERIC PHYSICS, ELECTRONICS AND COMPUTATIONAL PHYSICS

Unit-1: Atmospheric Physics and Earth's Atmosphere

Origin and composition of atmosphere: Fixed and variable gases, Mechanism of production and destruction of atmospheric constituents, Different layers of atmosphere. **2 hours**

Temperature structure of the atmosphere: Vertical profile and horizontal distribution, Pressure (over land and ocean), Variation of pressure with altitude, hydrostatic equation, Relative and Absolute humidity, Density (over land and ocean), wind (speed and direction). **3 hours**

Sun's Radiation : Spectrum of radiation (EM spectrum, Visible range, diffuse radiation), Black body radiation (Planck's law, emission curves from Sun and Earth atmosphere), Absorption of solar radiation by earth's atmosphere (absorption and emission of radiation by molecules, absorptivity, emissivity, Kirchoff's law, reflectivity and transmittivity), Beer's law (derivation), Global energy balance for earth – atmosphere system, Green house effect. **4 hours**

Atmospheric motions : Atmosphere dynamics – Eulerian and Lagrangian approaches ; Accelerated rotational frames of reference – Centripetal and Coriolis force, Gravity and pressure gradient forces (with derivation); Applications of Coriolis force – Formation of trade winds, cyclones, erosion of river banks. **6 hours**

Unit–2: Electronics

Integrated circuits : Monolithic IC - description of discrete IC - Techniques of manufacturing thin film and thick film IC. **2 hours**

Operational amplifiers : Ideal OP amplifier characteristics. The basic op-amp circuits, Inverting amplifier, Non-inverting amplifier; Applications of op-amp – summer, integrator, differentiator **3 hours**

Oscillators : Feedback concepts - oscillator circuits - Feedback amplifier - oscillator operation – Barkhausen Criterion - phase and frequency considerations- phase shift oscillator and Wien bridge oscillator (using op amp). **3 hours**

Digital Electronics : Logic states; Voltage range of high and low logic states; Number codes; Hexadecimal representation; BCD; signed numbers; Arithmetic 1's and 2's complement; Gray code.

Logic gates and truth tables; OR gate, AND gate; Inverter (the NOT function); NAND and NOR; exclusive OR; exclusive NOR. **5 hours**

Combination logic: Adders (full and half adder) & Subtractors (full and half). **2 hours**

Unit–3: Computational Methods in Physics (using C-program)

Basics of C Language : Program structure in C, Constants and Variables, Input and output statements, Arithmetic and conditional operations, conditional structure, Looping structures, one dimensional Arrays, programs to solve linear and quadratic equations. **3 hours**

Algorithms: modeling and simulation in physics: Errors in numerical calculations. **1 hour**

Roots of an equation : Newton-Raphson method and Bisection method. Application using Bisection method for LCR transient circuit (to determine R for given values of L and C for a pre-specified rate of dissipation of energy), program in C. **3 hours**

Numerical Integration: Simpson's 1/3 rule, Simpson's 3/8 rule, Applications - calculation of time period of a simple pendulum, rms current of ac, work done by variable force. **2 hours**

Numerical Differentiation: Newton – Forward and Backward formulae. Application: Problem on heat current: $H = -kA\frac{dT}{dx}$ **2 hours**

Ordinary Differential equation: Euler's method, Runge – Kutta II and IV order methods. Applications: Freely falling body in a resistive medium with resistance proportional to velocity, Projectile motion, LCR transient circuit, solution to Schrödinger wave equation for Harmonic potential (plotting wave function only). **4 hours**

References :

1. Basics of Atmospheric Science by **A Chandrashekar**, PHI Publications (2010).
2. Weather, climate and atmosphere by **Siddartha**.
3. Atmospheric Science by **John M Wallace and Peter V Hobbs**, Elsevier Publications (2006).
4. Introduction to Atmospheric Science by **Turberick and Lutzens**, Elsevier Publications
5. Computational Physics, An Introduction by **R C Verma, Ahluwalia, Sharma**
6. A first Course in Computational Physics by **Paul L. DeVries, Javier E. Hasbun**
7. Numerical Methods for Engineers by **Steven C. Chapra, Raymond P Canale**
8. C-Programming Language, ***Balaguruswamy E,*** Tata McGraw Hill (1999).
9. C-Programming Language, ***Xavier C***, New Age International (2000).
10. Computer Programming in C, **V RajaRaman,** PHI Learning Pvt. Ltd. (2004).

PHY-604: PRACTICAL PHYSICS VI (B)

1. Low pass filter using Op-amp
2. High pass filter using Op-amp
3. Band pass filter using Op-amp
4. Op-amp inverting and non-inverting amplifier.
5. Op-amp-summer, integrator, differentiator.
6. Phase shift oscillator using op –amp
7. Wien-bridge Oscillator using op – amp
8. Digital Half-adder & Full-adder circuits.
9. Temperature of atmospheric air - by using Thermograph (Bimetallic type)- Plotting the graph of temperature Vs time.
10. Relative humidity using hair hygrometer
11. Estimation of relative humidity using wet and dry bulb thermometer
12. Wind speed and direction by Hand held anemometer and wind wane
13. Estimation of height from the given pressure data

Execution of computer programs using C for the following problems.

14. (a) Determination of R in LCR transient circuit using Bisection method
    (b) Freely falling body in a resistive medium using Euler method / Runge – Kutta method
15. (a) Cooling of a body due to radiation – Stefan – Boltzmann Law using Euler method
    (b) rms current of ac using Simpson's rule
16. (a) Problem on heat flow using Newton Forward formula
    (b) Projectile motion with resistance using Euler method/Runge – Kutta method
17. (a) Work done by a variable force using Simpson's rule
    (b) LCR transient circuit – analysis – using Euler method
18. Schrödinger wave equation – Harmonic potential – Wave function plot only

Note : A Minimum of EIGHT experiments must be performed

References :

1. IGNOU : Practical Physics Manual
2. Saraf : Experiment in Physics
3. S.P. Singh : Advanced Practical Physics
4. Melissons : Experiments in Modern Physics
5. Misra and Misra, Physics Lab. Manual, South Asian publishers, 2000
6. Gupta and Kumar, Practcal physics, Pragati prakashan, 1976
7. Ramalingom & Raghuopalan : A Lab. Course in Electronics
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9. Computational Physics, An Introduction by **R C Verma, Ahluwalia, Sharma**
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