UNIVERSITY OF CALCUTTA

NotificationNo.CSR/01/21

It is notified for information of all concerned that the Syndicate at its meeting held on 25.01.2021 (vide Item No.31) subsequently confirmed by the short Resolution of the Syndicate approved the following amendments in the syllabus of Physics (Honours/General) courses of studies, notified under University notification no. CSR/12/18, dt. 04.6.18, applicable for the candidates who were admitted in the academic session 2018-2019, under CBCS :-

1) The Practical modules of all Core courses of Semesters-4, 5, 6 for Physics (Honours) are replaced by the revised practical modules, as laid down in the accompanying pamphlet.

2) The Practical modules of Core courses of Semesters-4 for Physics (General) are replaced by the revised practical modules, laid down in the accompanying pamphlet.

3) The candidates admitted in the academic session 2018-2019 in Physics (Honours/General) courses of studies will follow the syllabus for DSE Course (Semesters-5, 6; (Honours/ General), as mentioned in the CSR/47/19, dt. 11.11.19 instead of the CSR/12/18, dt. 04.6.2018

The above shall take immediate effect.

05/02/21

SENATE HOUSE

KOLKATA-700 073

The 5th February, 2021

Prof.(Dr.) Debasis Das

Registrar

REGISTRAR
UNIVERSITY OF CALCUTTA

Amendments in U.G. Syllabus
of
Physics (Honours and General)
(for the Academic Session 2018-2019)
University of Calcutta

Part I

Amendments : Honours Course

Amendments

Following amendments will be applicable for the Honours Course

- The practical modules of all the core courses in Semester 4,5 and 6 should be replaced by the practicals given here.

Honours: Semester 4

CC8, CC 9, CC 10

4.1 CC-8 Mathmatical Physics III

4.1.1 Mathematical Physics III (Practical)

Paper: PHS-A-CC-4-8-P	**Credit: 2**

1. Exploring Gaussian Integrals and the delta function **3 Lectures + 8 Classes**

- Numerically handling improper integrals over infinite intervals
- Numerically verifying the Gaussian integral result

$$\int_{-\infty}^{\infty} \exp\left(-ax^2+bx+c\right) = \sqrt{\frac{\pi}{a}} \exp\left(\frac{b^2}{4a}+c\right)$$

- Verifying that the convolution of two Gaussian function is a Gaussian
- Verifying that $\int_{a-x_1}^{a+x_2} \delta(x-a) f(x)\, dx = f(a)$ using different limiting representation of $\delta(x)$.

2. Solution of Differential Equation **3 Lectures + 6 Classes**

First order and 2nd order ODE by scipy.integrate.odeint().

3. Special functions **3 Lectures + 6 Classes**

Use of special functions taken from scipy.special. Plotting and verification of the properties of special functions. Orthogonality relations and recursion relations. Examples,

(a) $zJ'_\nu(z) + \nu J_\nu(z) = zJ_{\nu-1}(z)$

(b) $\left(1-x^2\right) P'_n(x) + (n+1)\, xP_n(x) - (n+1)\, P_{n+1}(x)$

(c) $\int_{-\infty}^{\infty} P_n(x)\, P_m(x)\, dx = \frac{2}{2n+1}\delta_{mn}$

4. Solution of some basic PDEs **5 Lectures + 20 Classes**

(a) Boundary value problems. Finite discrete method with fixed step sizes. Idea of stability. Application to simple physical problems.

(b) Laplace equation $\frac{\partial^2\phi}{\partial x^2} + \frac{\partial^2\phi}{\partial y^2} = 0$, on a square grid with specified potential at the boundaries.

(c) Wave equation in 1+1 dimension: $\frac{\partial^2\phi}{\partial t^2} = \lambda \frac{\partial^2\phi}{\partial x^2}$. Vibration of a string with ends fixed with given initial configurations: $\phi(x,0)$ and $\frac{\partial\phi}{\partial t}(x,0)$.

(d) Heat equation in 1+1 dimension, $\frac{\partial u}{\partial t} = \alpha \frac{\partial^2 u}{\partial x^2}$ with specified value of temperature at the boundaries with given initial temperature at the boundaries with given initial temperature profile.

5. Fourier Series **2 Lectures + 4 Classes**

Evaluate the Fourier coefficients of a given periodic function using scipy.integrate.quad(). Examples: square wave, triangular wave, saw-tooth wave. Plot to see a wave form from scipy.signal and the constructed series along with.

Reference Books

1. Numerical Analysis, Mathematics of Scientific Computing, David Kincaid, Ward Cheney, Reprint First Indian Edition 2013, American Mathematical Society
2. Numerical Methods for Engineers, 2nd Edition, D.V. Griffiths and I.M. Smith, , Chapman & Hall/CRC, Special Indian Edition
3. An Introduction to computational Physics, T.Pang, 2nd Edn., 2006,Cambridge Univ. Press
4. Scientific Computing in python, Avijit Kar Gupta, Techno World
5. Computational Physics problem solving with Computers, Landau, Paez, Bordeianu etextbook in Python 3rd Edition
6. Computational Methods for physcs, Joel Franklin, Cembridge University Press
7. Programming for Computation-Python, Svein Linge, Hans Petter Lantangen, Springer
8. Numerical Python, Robert Johansson, Apress Publication

4.2 CC-9 Modern Physics

4.2.1 Modern Physics (Practical)

Paper: PHS-A-CC-4-9-P	**Credit: 2**

List of Practicals

1. Measurement of Plank constant using LED

2. Verification of Stefan's law of radiation by the measurement of voltage and current of a torch bulb glowing it beyond draper point.

3. Determination of e/m of electrons by using bar magnet.

4. To study the photoelectric effect: variation of photocurrent versus intensity and wavelength of light.

5. To show the tunneling effect in tunnel diode using I-V characteristics.

Reference Books

1. B.Sc. Practical Physics, C.L. Arora, S. Chand And Company Limited
2. Practical Physics Vol 1, Vol 2, B. Ghosh, K. G. Majumder, Sreedhar Publisher

4.3 CC-10 Analog System and Applications

4.3.1 Analog Systems and Applications (Practical)

Paper: PHS-A-CC-4-10-P	**Credits: 2**

List of Practicals

1. To study the reverse characteristics of Zener diode and study the load and line regulation.

2. To study the static characteristics of BJT in CE Conguration.

3. To design and study the frequency response of the BJT amplifier in CE mode.

4. Construction of a series regulated power supply from an unregulated power supply.

5. To study OPAMP: inverting amplifer, non inverting amplier, adder, substractor, comparator, Schmitt trigger, Integrator, differentiator, relaxation oscillator.

6. To design a Wien bridge oscillator for given frequency using an op-amp.

Reference Books

1. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill
2. Advanced Practical Physics (volume II), B. Ghosh , Shreedhar Publication
3. An Advanced Course in Practical Physics, D. Chattopadhyay, P.C. Rakshit, New Central Book Agency (P) Ltd
4. Laboratory Manual for Operational Amplifiers and Linear ICs, David A. Bell, Prentice Hall of India Pvt Ltd.

Honours: Semester 5

CC 11, CC 12

5.1 CC-11 Quantum Mechanics

5.1.1 Quantum Mechanics (Practical)

Paper: PHS-A-CC-5-11-P **Credit:2**

1. Finding eigenstates solving transcendental equation **3 Lectures + 6 Classes**

To find eigenvalues of the bound state particle of mass in a one dimensional potential well by solving the transcendental equation that appears as the eigenvalue condition (graphs are to be plotted for appropriate guess values, scipy root searching package may be used) and to plot the eigenfunctions.

2. Use of shooting algorithm **7 Lectures + 20 Classes**

Shooting algorithm for solving bound state problems (solving the ode using both Euler and Numerov algorithms) : conversion to dimensionless variable, eigenvalues and eigenvectors of the ground and first excited states.

- in one dimension (for example, the Harmonic oscillator, the Morse potential, the triangular well etc.)
- the s wave radial equation for a particle moving in a central potential, $\frac{d^2U(r)}{dr^2} = A(r)U(r)$ where $A(r) = \frac{2m}{\hbar^2}[V(r) - E]$
  some Examples

  - ☐ $V(r) = -\frac{e^2}{r}$
  - ☐ $V(r) = -\frac{e^2}{r}e^{-r/a}$
  - ☐ $V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3$
  - ☐ $V(r) = D\left(e^{-2\alpha r'} - e^{-\alpha r'}\right)$,
    where $r' = \frac{r-r_0}{r}$

3. Time Evaluation of Wave Packet **6 Lectures + 18 Classes**

- Time evolution of a wave packet moving in free space by the numerical solution of the time dependent Scrödinger equation.

- Solving the TDSE to study Barrier penetration and tunneling for an initially Gaussian wavepacket.

Reference Books

1. An Introduction to computational Physics, T.Pang, 2nd Edn., 2006,Cambridge Univ. Press
2. Scientific Computing in Python, Abhijit Kar Gupta, Techno World
3. Computational Physics problem solving with Computers, Landau, Paez, Bordeianu etextbook in Python 3rd Edition
4. Computational Methods for physcs, Joel Franklin, Cembridge University Press
5. Computational Quantum Mechanics, Joshua Izaac, Jingbo Wang, Springer

5.2 CC-12 Solid State Physics

5.2.1 Solid State Physics (Practical)

Paper: PHS-A-CC-5-12-P	**Credits: 2**

List of Practicals

1. To study BH hysteresis of ferromagnetic material
2. To determine dielectric constant of different materials (solid and liquid) using fixed frequency alternating source.
3. Measurement of variation of resistivity in a semiconductor and investigation of intrinsic band gap using linear four probe.
4. Measurement of hall voltage by four probe method
5. To study temperature coefficient of a semiconductor (NTC thermistor) and construction of temperature controller with comperator and relay switch.
6. Measurement of magnetic susceptibility of solids

Reference Books

1. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
2. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
3. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice Hall of India

Honours: Semester 6

CC 13, CC 14

6.1 CC-13 Electromagnetic Theory

6.1.1 Electromagnetic Theory (Practical)

Paper: PHS-A-CC-6-13-P	**Credit: 2**

List of Practicals

1. To determine Brewster's angle for air-glass interface using a prism.
2. To study Fresnels law by the reflection on the surface of a prism.
3. To verify the Malus law using a pair of polaroids.
4. To study the specific rotation of optically active solution using polarimeter.
5. To determine dispersive power and resolving power of a plane diffraction grating

Reference Books

1. Advanced Practical Physics (Vol 1 & Vol 2), B. Ghosh, K. G. Majumder, Sreedhar Publication

6.2 CC-14 Statistical Mechanics

6.2.1 Statistical Mechanics (Practical)

Paper: PHS-A-CC-6-14-P	**Credit: 2**

1. Study of Random Numbers and Time series **5 Lectures + 15 Classes**

Introduction to the numpy.random() module

- Histogram (by matplotlib.pyplot.hist) and autocorrelation function of a given time series.
- Generating exponential variates from uniform variate using transformation

- Gaussian variate from uniform variate using central limit theorem.
- Study of histogram and moments of random sequences of different probability density using numpy.random.

2. Applications of Random Numbers **8 Lectures + 20 Classes**

- Coin tossing. Fit with binomial distribution.
- Nuclear Decay: Simulation assuming a constant decay probability per unit time.
- Random Walk:
  - In 1D and in 2D (Square grid)
  - Plot of r.m.s. value of end to end distance as a function of time step
  - fitting and finding of exponent
- Monte Carlo Integration

3. Scaling and plots, exponents and parameters: **4 Lectures + 8 Classes**
Laws and distributions from Statistical Mechanics
Some Problems

- Maxwell-Boltzmann distribution
- Bose-Einstein distribution
- Fermi-Dirac distribution
- Plot of specific Heat of Solids
  - Dulong-Petit law
  - Einstein distribution function
  - Debye distribution function for high temperature and low temperature and compare them for these two cases

Reference Books

1. Introduction to Modern Statistical Mechanics, D. Chandler, Oxford University Press, 1987
2. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
3. Statistical and Thermal Physics with computer applications, Harvey Gould and Jan Tobochnik, Princeton University Press, 2010
4. Scientific Computing in Python. Abhijit Kar Gupta, Techno World
5. Computatioal Physics problem solving with Computers, Landau, Paez, Bordeianu etextbook in Python 3rd Edition
6. Computational Methods for physcs, Joel Franklin, Cembridge University Press

Part II

Amendments: General Course

Amendments

Following amendments will be applicable for the Geneal Course

- Practicals prescribed in semester 4 in CC4/GE4 should be replaced by the practicals proposed here.

General: Semester 4

CC4/GE4

4.0.1 Waves and Optics (Practical)

Paper: PHS-G-CC-4-4-P	**Credits: 2**

List of Practicals

1. Determination of the focal length of a concave lens by auxiliary lens method.

2. Determination of the frequency of a tuning fork with the help of sonometer.

3. Determination of radius of curvature of plano convex lens/wavelength of a monochromatic or quasi monochromatic light using Newtons ring.

4. Measurement of thickness of a paper from a wedge shaped film.

5. Measurement of specific rotation of active solution (e.g., sugar solution) using polarimeter.

Reference Books

1. Practical Physics, P.R. Sasi Kumar, PHI Learning Private Limited
2. B.Sc. Practical Physics, Harnem Singh, P.S. Hemne, S Chand and Company Limited
3. B.Sc. Practical Physics, C.L. Arora, S Chand and Company Limited
4. Advanced Practical Physics, Vol 1 & 2, B. Ghosh, K.G.Majumdar, Shreedhar Publishers