KOLHAN UNIVERSITY, CHAIBASA

JHARKHAND

Revised Curriculum and Credit Frame

For SEM – II

As per FYUGP, NEP- 2020

(U.G. Physics-2022 Onwards)

University Department of Physics

Kolhan University, Chaibasa

West Singhbhum, Jharkhand

833202

Index

Sem	Code	Papers	Credits (Th + P)
II	MJ 2	Major Paper -2 (Mathematical Physics - 1)	3 + 0
	MJ 3	Major Paper -3 (Electricity & Magnetism - 1)	3 + 0
	MJ 2	Practical of MJ 2 & MJ 3	0 + 2
	MN 2A	From Vocational Studies/ Discipline	3 + 1

Semester-II

Paper Title: Major Paper -2-Mathematical Physics (MJ-2)

Credits - 03

Learning objective:

After completing this course, student will be able to,

- Use curvilinear coordinates to solve problems with spherical and cylindrical symmetries
- Represent a periodic function by a sum of harmonics using Fourier series
- Obtain power series solution of differential equation of second order with variable coefficient using Frobenius method
- Understand the properties and applications of Legendre polynomials
- Learn about gamma and beta functions and their applications

Mathematical Physics - 1

FM−60 Marks (Theory) Time 3hrs

Instruction to Question Setter for End Semester Examination (ESE): There will be two groups of questions. Five Questions to be answered out of Nine Questions. Group A is compulsory and will contain two questions. Question No.1 (A) will be MCQ of 1 mark each (six questions). Question No.1 (B) will be short answer type to be answered in about 50 words of 3 marks (2 Questions). Group B will contain descriptive type eight questions of twelve marks each, out of which any four are to answer. Each question carries 12 marks.

Full Marks-60 Credit-03

Mathematical Physics:-1

UNIT – I

Orthogonal Curvilinear Coordinates: Orthogonal Curvilinear Coordinates. Scale factors, element of area and volume in spherical and cylindrical coordinate Systems. Derivation of Gradient, Divergence, Curl and Laplacian in Spherical and Cylindrical Coordinate Systems, Gauss
Divergence theorem, Stokes theorem, Green's theorem (15 Hours)

UNIT-II

Fourier Series: Periodic functions, Orthogonality of sine and cosine functions, Convergence of Fourier series and Dirichlet Conditions (Statement only), Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients, Even and odd functions and their Fourier expansions (Fourier Cosine Series and Fourier Sine Series),
Parseval's Identity. (10Hours)

UNIT – III

Frobenius Method and series solution of Differential Equations: Singular Points of Second Order Linear Differential Equations and their importance, Frobenius method for finding series solution and its applications, Legendre Differential Equations and its solution. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality of Legendre Polynomials, Simple recurrence relations, Expansion of function in a series of Legendre Polynomials. Some Special Integrals: Beta and Gamma Functions and relation between them, Expression of Integrals in terms of Gamma and Beta
Functions. (20 Hours)

References:

Essential Readings:

1) Mathematical Methods for Scientists and Engineers, D. A. McQuarrie, 2003, Viva Book.

2) Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.

3) Essential Mathematical Methods, K. F. Riley and M. P. Hobson, 2011, Cambridge Univ. Press.

4) Vector Analysis and Cartesian Tensors, D. E. Bourne and P. C. Kendall, 3 Ed., 2017, CRC Press.

5) Vector Analysis, Murray Spiegel, 2nd Ed., 2017, Schaum's Outlines Series.

7) Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.

8) Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber, F. E. Harris, 7 Ed., 2013, Elsevier.

Additional Readings:

1) Introduction to Electrodynamics, Chapter 1, David J. Griffiths, 4 Ed., 2017, Cambridge University Press.

2) The Feynman Lectures on Physics, Volume II, Feynman, Leighton and Sands, 2008, Narosa Publishing House.

3) Advanced Engineering Mathematics, D. G. Zill and W. S. Wright, 5 Ed., 2012, Jones and 62 Bartlett Learning.

4) Introduction to Vector Analysis, Davis and Snider, 6 Ed., 1990, McGraw Hill.

5) Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.

6) Mathematical Physics, A. K. Ghatak, I. C. Goyal and S. J. Chua, 2017, Laxmi Publications Private Limited.

ELECTRICITY AND MAGNETISM-1

Paper Title: Major Paper -3-Electricity and Magnetism-1 (MJ-3)

Credits - 03

LEARNING OUTCOMES:

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

- Understand Gauss' law, Coulomb's law for the electric field, and apply them to systems of point charges as well as line, surface, and volume distributions of charges. Also to use the knowledge to solve some simple problems
- Express electric current and capacitance in terms of electric field and electric potential.
- Calculate the force experienced by a moving charge in a magnetic field
- Determine the magnetic force generated by a current carrying conductor
- Have brief idea of magnetic materials, understand the concept of electromagnetic induction, solve problems using Faraday's and Lenz's laws

Full Marks - 60 Credit-03

Instruction to Question Setter for End Semester Examination (ESE): There will be two groups of questions. Five Questions to be answered out of Nine Questions. Group A is compulsory and will

contain two questions. Question No.1 (A) will be MCQ of 1 mark each (six questions). Question No.1 (B) will be short answer type to be answered in about 50 words of 3 marks (2 Questions). Group B will contain descriptive type eight questions of twelve marks each, out of which any four are to answer. Each question carries 12 marks.

UNIT-1 Electric Field and Electric Potential:

Conservative nature of Electrostatic Field. Electrostatic Potential . Laplace's and Poisson equations & its solution in Cartesian coordinates, The Uniqueness Theorem. Gauss' law in integral and differential form. Multipole expansion (monopole, dipole & quadrapole), energy density in an electric field. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere. (10 Lectures)

UNIT-II Dielectric Properties of Matter:

Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector D. Relations between E, P and D. Gauss' Law in dielectrics. (6 Lectures)

UNIT-III Transients:

Growth and Decay of currents in LR, CR , LC and LCR circuits . (4 Lectures)

UNIT-IV Magnetic Properties of Matter:

Magnetization vector (M). Magnetic Intensity (H). Magnetic Susceptibility and permeability. Relation between B, H, M. Ferromagnetism. B-H curve and hysteresis. (8 Lectures)

UNIT-V Electrical Circuits:

Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit. Anderson's bridge, De Sauty's Bridge and Owen's bridge & their vector diagram representation. Three phase electrical power supply, delta and star connections. (10 Lectures)

UNIT-VI Network theorems:

Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Maximum Power Transfer theorem and Superposition Theorem. Ballistic Galvanometer: Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. (7 Lectures)

Reference Books:

1. Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, TMH 10
2. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
3. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
4. Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education
5. Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press
6. Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ. Press.
7. Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House. 8. Electricity and Magnetism K K Tewary S. Chand and Company.

Practical Paper: MJ2 + MJ3

Practical: Credit: 02 60 Hours

Here is a list of experiments that cover a range of instruments, circuits, and data recording and analysis techniques:

To use a multimeter for measuring resistances, a.c and d.c voltages, d.c. current, capacitance and for checking electrical fuses.

Ballistic Galvanometer:

(a) Measurement of charge and current sensitivity

(b) Measurement of critical damping resistance

(c) Determine a high resistance by leakage method

(d) Determine self-inductance of a coil by Rayleigh's Method.

- To compare capacitances using de Sauty's bridge.
- Measurement of field strength B and its variation in a Solenoid
- To study the Characteristics of a Series RC Circuit.
- To study a series LCR circuit and determine its resonant frequency and quality factor.
- To study a parallel LCR circuit and determine its anti-resonant frequency and quality factor
- To determine a low resistance by Carey Foster bridge.
- To verify the Thevenin, superposition and maximum power transfer theorems
- To verify Norton theorem

Remember, each student should perform at least 6 experiments from the above list, so you can choose the ones that align with your curriculum and available resources.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed.] 2011, KitabaMahal
3. Advanced level Physics Practicals, Micheal Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publisers
4. Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learing.
5. A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal, 1985, Vani Pub.
6. B.Sc. Practical Physics, N.N. Ghosh, Bharati Bhawan Publishers.
7. B.Sc. Practical Physics, C.L. Arora, S. Chand & Company, 19th Edition, 1995, reprint 2014.

Computer programming and numerical analysis: Paper-MJ3

It emphasizes in solving problems in Physics. The course will include practical sessions and lectures covering the related theoretical aspects of the laboratory. Assessment will be based not only on the programming skills but also on the ability to formulate problems.
Each student is required to complete a minimum of 12 programs, covering all the units. The list of recommended programs serves as a guide, and students are encouraged to engage in additional practice. It is important to prioritize the formulation of physics problems as mathematical ones and solve them using computational methods.
The implementation can be done in either Python, C++, or Scilab.

Unit 1: Root Finding:

Bisection, Newton- Raphson and secant methods for solving roots of equations,Convergence analysis. Recommended List of Programs (At least two):

(a) Determine the depth up to which a spherical homogeneous object of given radius and density will sink into a fluid of given density.

(b) Solve transcendental equations like $\alpha = \tan(\alpha)$.

(c) To approximate nth root of a number up to a given number of significant digits.

Unit 2: Least Square fitting (At least one):

Algorithm for least square fitting and its relation to maximum likelihood for normally distributed data.

Make a function for least square fitting, use it for fitting given data (x, y) and estimate the parameters a, b as well as uncertainties in the parameters for the following cases

i. Linear ($y = ax + b$)
ii. Power law ($y = ax^b$)
iii. Exponential ($y = ae^{bx}$)

(b) Weighted least square fitting of given data (x, y) with known error/uncertainty-values using user defined function.

Unit 3: Generating and plotting of a function using series representation (At least one):

a) To approximate the elementary functions (e.g. exp(x), sin(x), cos(x), ln (1+x), etc.) by a finite number of terms of Taylor's series and discuss the truncation error. To plot the function as well the nth partial sum of its series for various values of n on the same graph and visualize the convergence of series.

b) Generating and plotting Legendre Polynomials using series expansion and verifying recurrence relation

Unit 4: Interpolation:

Concept of Interpolation, Lagrange form of interpolating polynomial, Error estimation, optimal points for interpolation. Recommended List of Programs (At least one)

(a) Write program to determine the unique polynomial of a degree n that agrees with a given set of (n+1) data points (x_i, y_i) and use this polynomial to find the value of y at a value of x not included in the data.

(b) Generate a tabulated data containing a given number of values (xi, f(xi)) of a function f(x) and use it to interpolate at a value of x not used in table.

References for (for Laboratory work):

1) Documentation at the Python home page (https://docs.python.org/3/) and the tutorials there (https://docs.python.org/3/tutorial/).

2) Documentation of NumPy and Matplotlib: https://numpy.org/doc/stable/user/ and https://matplotlib.org/stable/tutorials/

3) Computational Physics, Darren Walker, 1st Edn., Scientific International Pvt. Ltd (2015).

4) Elementary Numerical Analysis, K. E. Atkinson, 3rd Edn., 2007, Wiley India Edition.

5) An Introduction to Computational Physics, T. Pang, Cambridge University Press (2010).

6) Introduction to Numerical Analysis, S. S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.

7) Applied numerical analysis, Cutis F. Gerald and P. O. Wheatley, Pearson Education, India (2007).

8) Numerical Recipes: The art of scientific computing, William H. Press, Saul A. Teukolsky and William Vetterling, Cambridge University Press; 3rd edition (2007)

9) Computational Problems for Physics, R. H. Landau and M. J. Páez, 2018, CRC Press.

The distribution of practical marks is as follows (25Marks)

(a) Experiment-15 Marks, (b)Viva Voce-05 Marks,(c)Practical Record-05 Marks

The distribution of 15 Marks is as follows

(a) Class room participation and attendance-05 Marks, (b) Internal test-10Marks.

Kolhan University, Chaibasa

End-Semester Examination xxxx (Session: xxxx-xx)

Subject/Code:

Full Marks: 60 Pass Marks: 24 Time: 3Hours

General Instructions:

Candidates are required to give their answers in their own words as far as practicable.

The Questions are of equal value.

Answer any five questions of the following in which Q.1 is compulsory.

Group A

1. (A) Multiple Choice Questions (1x6=06)

(i) ……..

(ii) ……..

(iii) ……..

(iv) ……..

(v) ……..

(vi) ……..

(B) Short answer type questions (3x2=06)

(a) ……..

(b) ……..

(c) ……..

Group B

(Long answer type questions)

Answer any four of the following. (12x4=48)

2. ……..

3. ……..

4. ……..

5. ……..

6. ……..

7. ……..

8. ……..