NEP PG

1-YEAR CURRICULUM

M.Sc. PHYSICS PROGRAMME

SUBJECT CODE = PHY

FOR POSTGRADUATE COURSES UNDER RANCHI UNIVERSITY, RANCHI

Implemented w.e.f.
Academic Session 2026-27 Onwards

UNIVERSITY DEPARTMENT OF PHYSICS
RANCHI UNIVERSITY, RANCHI

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Ref. No. : Phy P.G. .....

Date : .....

Board of Studies
FYUGP 2025 Curriculum & 1-Year/2-Year PG Curriculum 2025

Chairman : Dr. Sunil Kumar Singh
Associate Professor & Head
University Department of Physics
Ranchi University, Ranchi

11/07/2025

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2. Prof. N. N. Ojha, (Retd.) Head, Deptt. of Physics, DSPMU, Ranchi

11.07.2025

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5. Dr. Nand Kumar Rana
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11/7/2025

Student Representative:

1. Miss. Palak Priya Kumari, Sem-IV (2023-25)

Palak Priya Kumari 11/07/25

2. Miss. Roqayah Saman, Sem-I (2024-26)

Roqayah Saman 11/07/25

Approval by the Members of the NEP Implementation and Monitoring Committee of Ranchi University, Ranchi

The prepared Curriculum of the Master's Degree has been approved by the NEP Implementation and Monitoring Committee of R.U., duly forwarded by the Head of the Department; it will be offered to the Students of the 1-year and 2-year Postgraduate Programme. It is implemented from the 1st Semester of the Academic Session 2025-26 and onwards.

10/9/25 10/9/25 10/9/2025

Anushka Rani 10/09/25 10/9/25 10/9/25

10/9/25 10/9/25 10/09/2025

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Member Secretory

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HIGHLIGHTS OF NEP PG CURRICULUM

CREDIT OF COURSES

The term 'credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. The workload relating to a course is measured in terms of credit hours. It determines the number of hours of instruction required per week over a semester (minimum 15 weeks).

a) One hour of teaching/ Lectures or two hours of laboratory /practical work will be assigned per class/interaction.
One credit for Theory = 15 Hours of Teaching
One credit for Practicum = 30 Hours of Practical work
One credit for Internship = 02 Weeks of Practical experience

b) For credit determination, instruction is divided into three major components:
Hours (L) – Classroom Hours of one hour duration.
Tutorials (T) – Special, elaborate instructions on specific topics of one hour duration
Practical (P) – Laboratory or field exercises in which the student has to do experiments or other practical work of a two-hour duration.

Internship – For the Exit option after 1st year of the 2-year P.G. Programme for the award of P.G. Diploma, Level 6.5, Students can either complete two 4-week internships worth 2 credits each or one 8-week internship for all 4 credits. This practical experience connects academic learning with real-world applications, offering valuable exposure to professional environments in their fields of study

PG CURRICULUM

1. The PG Curriculum will be either of 1-year duration for students who studied the four-year UG Programme (FYUGP) or a 2-year duration for students who studied a three-year UG programme from a CBCS/LOCF/FYUGP Curriculum.
2. There is a flexible mode in the PG programme offered to the students of Ranchi University, Ranchi. The total credit for any semester will be 20 credits.
3. **One-year PG curriculum:** The Courses in the 1-year PG programme and the second year of the 2-year PG programme are the same.
   a. **Course work only**: There will be 5 courses at level 500 of 4 credits each in every semester for the coursework offered in the programme.
   b. **Course work and Research**: There will be 5 courses at the level 500 bearing 4 credits each in the first semester of a 1-year PG or in the third semester of a 2-year PG. Research work will be offered in the next semester for this mode of the programme. The eligibility for this mode is available in the NEP PG curriculum of Ranchi University, Ranchi.
   c. **Research work only**: The eligible student will be offered this mode to conduct extensive research under the supervision of a guide. Each semester will be equivalent to 20 credits. The selection of a candidate for the research mode will depend upon the eligibility of the student, availability of the guide and seat in the department/institution of Ranchi University, Ranchi.

PROMOTION CRITERIA

One Year Post-graduation programme having coursework only:

i. Each course shall be of **100 marks,** having two components: **30 marks for Sessional Internal Assessment (SIA), conducted by the Department/College and 70 marks shall be assigned to the End Semester University Examination (ESUE), conducted by the University**.
ii. The marks of SIA shall further break into 20 for Internal Written Examinations, 05 for Written Assignment/ Seminar presentation and 05 for overall performance of a student, including regularity in the classroom lectures and other activities of the Department/College.
iii. The Requisite Marks obtained by a student in a particular subject will be the criterion for promotion to the next Semester.
iv. There shall be two written internal examinations, each of 1 hour duration and each of 20 marks, in a semester, out of which the '**better of the two**' shall be taken for computation of marks under SIA.

v. If a student failed to secure pass marks in the Mid Semester Examination, he/she has to reappear in Mid & End Semester Examinations, of the following year.

vi. In case a student fails to secure pass marks in End Semester Examination, then he/she has to appear only in the End Semester Examination of the following session within the period of Upper Limit of Two Years and the Marks of the Mid Semester will be carried for the preparation of the result.

vii. Students' final marks and the result will be based on the marks obtained in the Mid Semester and End Semester Examination taken together.

viii. The pass marks in the programme will be 45% of the total marks obtained in each Core/ Elective/ Other Courses offered.

ix. In absolute terms of marks obtained in a course, **a minimum of 28 marks is essential in the ESUE** and **a minimum of 17 marks is to be secured in the SIA** to clear the course. In other words, a student shall have to pass separately in the ESUE and in the SIA by securing the minimum marks prescribed here.

x. Every candidate seeking to appear in the ESUE shall be issued an Admit Card by the University. **No candidate will be permitted to appear in the examination without a valid admit card.**

xi. A candidate shall be permitted to proceed in the next Semester (2^{nd}), **provided he/she has passed at least 3 courses out of 5 courses** in the respective semester in theory and practical/ project courses taken together.

xii. A student will have to clear all his/her papers within a maximum of Two Years of duration to qualify for the degree.

However, it will be necessary to procure pass marks in each of the papers before completion of the programme.

VALUE-ADDED COURSES

1. The Value-added course will be of **2 credits** to be covered during the first semester.
2. The End Semester University Examination (ESUE) of this course will comprise 50 objective-type questions of 1 mark each.
3. ESUE shall be OMR-based and the correct option is to be marked by a black ballpoint pen.
4. For the **50 Marks Examination,** the student will be provided **two hours** to mark their responses.
5. Students are not allowed to choose or repeat courses already undergone at the undergraduate level in the proposed major and minor streams.
6. The performance in this course will not influence the SGPA or CGPA of the PG Programme wherein the student is registered to obtain the Master's Degree. However, it will be mandatory to secure minimum pass marks in the course before exiting the Programme.
7. If a student fails to secure the minimum pass marks in this course in the first semester, he/she must reappear in the examination of the said course with the following batch of the next session.
8. The student may appear in the examination of the said course further if they could not clear the course in the following attempt, subject to the date of validation of the Registration.

The existing Regulations of the PG Curriculum of Ranchi University, Ranchi, shall guide the Regulations related to any concern not mentioned here.

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COURSE STRUCTURE FOR **'PG COURSEWORK/ COURSEWORK WITH RESEARCH/ RESEARCH ONLY'**

Table 1: Credit Framework for One Year Postgraduate Programme [Total Credits = 40]

Academic Level	Level of Courses	Semester	Coursework Level 400	Coursework Level 500	Research Preparedness	Research thesis/ Project/ Patent	Total Credits
YEAR 1							
Level 6.5	**Coursework**	**III**	**---**	**4+4+4+4+4**	**---**	**---**	**20**
		IV	**---**	**4+4+4+4+4**	**---**	**---**	**20**
OR							
Level 6.5	**Coursework + Research**	**III**	**---**	**4+4+4+4+4**	**---**	**---**	**20**
		IV	**---**	**---**	**20**		**20**
OR							
Level 6.5	**Research**	**III**	**---**	**---**	**20**	**---**	**20**
		IV	**---**	**---**	**---**	**20**	**20**
Total credits = **40**							

Note:

1. **Every student has to take any one Value-added course of 2-credits compulsorily in the 1st Semester of PG programme.**
2. **There is no provision of 'Exit' in the 1-Year PG Programme.**

AIMS OF MASTER'S DEGREE PROGRAMME IN PHYSICS

The M.Sc. Physics program wish to provide students a strong conceptual base, the ability to analyze things, the ability to do research, and an ethical scientific outlook. This is in line with the ideas of NEP-2020, which stress critical thinking, research orientation, employability, and lifelong learning. By combining theory, experimentation, computation, and innovation, the program gets students ready for college, research, teaching, and work. The program has certain objectives that will help students:

1. Develop advanced theoretical and experimental skills in both established and new areas of physics.
2. Use math, computers, and numbers to model and solve problems in the real world.
3. Learn how to do research, such as how to read scientific papers, come up with hypotheses, analyze data, and write scientific reports.
4. Learn how to use modern lab tools and computers in real life.
5. Use knowledge from different fields and apply physics principles to problems in the real world and in society.
6. Be able to talk about scientific ideas clearly and work well with others in a professional setting.
7. Be aware of your social responsibility, do ethical research, and be aware of sustainability.
8. Get ready for doctoral research, competitive exams, teaching, and jobs in the business world.

PROGRAMME LEARNING OUTCOMES

After completing the M.Sc. Physics program, graduates will be able to:

1. Show a deep understanding of the basic ideas and theories in most areas of physics.
2. Use analytical, mathematical, and numerical methods to find, formulate, and solve difficult physical problems.
3. Use the right tools, instruments, and error analysis methods to plan, carry out, and look at advanced experiments.
4. Use programming, simulation tools, and computational methods to model physical systems and look at data.
5. Do your own research that includes the literature survey, testing hypotheses, interpreting data, and making critical evaluations.
6. Use physics ideas in fields like materials science, nanotechnology, energy, electronics, and environmental science that are not strictly physics.
7. Use technical writing, presentations, and academic discussions to get scientific ideas across clearly.
8. Show that you are ethically responsible in your research, data management, intellectual property, and professional behaviour.
9. Be able to work well alone and as a member or leader of multidisciplinary teams.
10. Learn on your own and for the rest of your life so you can keep up with new scientific discoveries and professional challenges.

Programme Specific Outcomes (PSOs)

After completing the program, students will be able to

1. Use advanced ideas from classical mechanics, quantum mechanics, electrodynamics, and statistical mechanics to study physical systems.
2. Use advanced lab equipment, understand experimental data, and use uncertainty and error analysis in physics experiments.
3. Create and use computer models and numerical algorithms to solve physics problems and model physical events.
4. Look at the physical properties of materials and use ideas from solid-state and condensed matter physics to make things work better.
5. Do a supervised research project or dissertation on your own and present the results in a way that is scientifically sound.

The Courses in 1 Year P.G. Programme and in the Second year of 2 years P.G. Programme are Common.

Table 2: Semester-wise Course Code and Credit Points

Sem	Core, AE/ GE/ DC/ EC & Compulsory FC Courses				Examination Structure		
	Paper	Paper Code	Credit	Name of Paper	Mid Semester Evaluation (F.M.)	End Semester Evaluation (F.M.)	End Semester Practical/ Viva (F.M.)
I	Core Course	CCPHY311	4	Ancient Indian Physics (IKS)	30	70	----
	Skill Enhancement Course	ECPHY312	4	A. Numerical Methods & Simulation/ B. Experimental Techniques	30	70	----
	Core Course	CCPHY313	4	Advanced Nuclear Physics-II	30	70	----
	Core Course	CCPHY314	4	Statistical Physics	30	70	----
	Practicals on Core	CPPHY315	4	Practical	----	----	100
II	Elective	ECPHY411	4	A. Nanophysics and Nanomaterials-I/ B. Electronics and Communication-I/ C. Condensed Matter Physics-I	30	70	----
	Elective	ECPHY412	4	A. Nanophysics and Nanomaterials-II/ B. Electronics and Communication-II/ C. Condensed Matter Physics-II	30	70	----
	Core Course	CCPHY413	4	Atmospheric Physics	30	70	----
	Practicals on Elective	EPPHY414	4	A. Nanophysics and Nanomaterials Lab/ B. Electronics and Communication Lab/ C. Condensed Matter Physics Lab	----	----	100
	PROJECT	PRPHY415	4	Dissertation/ Project/ Teaching Aptitude	----	----	100

Note:

1. **Every student has to take any one Value-added course of 2-credits compulsorily in the 1st Semester of PG programme.**
2. **There is no provision of 'Exit' in the 1-Year PG Programme.**

INSTRUCTION TO QUESTION SETTER

SEMESTER INTERNAL EXAMINATION (SIE):

There **Marks Weightage of a Course:** Each non-practical/non-project course shall be of **100 marks** having two components: **70 marks shall be assigned to the End Semester University Examination (ESUE), conducted by the University, and, 30 marks for Sessional Internal Assessment (SIA), conducted by the Department/College**.

The marks of SIA shall further break into, 20 for Internal Written Examinations, 05 for Written Assignment/ Seminar presentation and 05 for overall performance of a student including regularity in the class room lectures and other activities of the Department/College. There shall be two written internal examinations, each of 1-hour duration and each of 20 marks, in a semester out of which **'Better of the Two'** shall be taken for computation of marks under SIA.

In absolute terms of marks obtained in a course, **a minimum of 28 marks is essential in the ESUE and a minimum of 17 marks is to be secured in the SIA to clear the course**. In other words, a student shall have to pass separately in the ESUE and in the SIA by securing the minimum marks prescribed here.

A. (SIE 20+5=25 marks):

There will be a uniform pattern of questions for mid semester examinations in all the courses and of all the programmes. There will be **two** groups of questions in 20 marks written examinations. **Group A is compulsory** and will contain five **very short answer type** questions consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered. Department may conduct Sessional Internal Examinations in other format as per need of the course.

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 20 Marks, (b) Class Attendance Score (CAS) of 5 marks.

Conversion of Attendance into score may be as follows:

Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks.

END SEMESTER UNIVERSITY EXAMINATION (ESUE):

A. (ESUE 70 marks):

There will be a uniform pattern of questions for all the courses and of all the programmes. There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** questions consisting of five questions of 1 mark each. **Question No.2 will be short answer type** questions of 5 marks. **Group B will contain six descriptive type** questions of 15 marks each, out of which any four questions are to be answered. The questions will be so framed that examinee could answer them within the stipulated time.

[**Note:** There may be subdivisions in each question asked in Theory Examinations]

B. (ESUE 100 marks):

Practical/ Project courses would also be of 100 marks but there **shall be no internal written examinations** of the type specified above. The total 100 marks will have two components: **70 marks for the practical ESUE and 20 marks for the Viva-voce examination** conducted during the ESUE to assess the applied and practical understanding of the student.

The written component of the project (**Project Report**) shall be of **70 marks and 20 marks will be for the Viva-voce examination** jointly conducted by an external examiner, appointed by the University, and the internal supervisor/guide.

10 marks will be assigned on cumulative assessment of examinee during the semester and will be awarded by the department/faculty concerned.

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FORMAT OF QUESTION PAPER FOR MID/ END SEMESTER EXAMINATIONS

Question format for **20 Marks**:

Subject/ Code

F.M. =20 **Time**=1Hr. Exam Year

General Instructions:

i. **Group A** carries very short answer type compulsory questions.
ii. **Answer 1 out of 2** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]

Group B

3. ..... [10]
4. ..... [10]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **70 Marks**:

Subject/ Code

F.M. =70 **Time**=3HrS. Exam Year

General Instructions:

i. **Group A** carries very short answer type compulsory questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]

Group B

3. ..... [15]
4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

SEMESTER I

I. CORE COURSE [CCPHY311]

ANCIENT INDIAN PHYSICS (IKS)

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

(Credits: Theory-04, 60 Hours)

Course Objectives:

1. To understand the ancient Indian physics at the deepest level.
2. To gain deeper knowledge of the astronomical topics in Siddhantas, planetary motions and the governing laws, and the various astronomical instruments developed and in-use in the ancient days.

Course Learning Outcomes:

1. Understanding of the ancient Indian astronomy and its contribution to the development of the modern astronomy.
2. Understanding of the various Indian astronomers and their contribution in developing the foundational astronomical laws and instruments.

Contents:

Some Astronomical topics in Siddhantas. The Sphere and some important great circle, Coordinates, Latitude, Zenith, Distance and Declination, relation between the Declination, the Longitude and the Obliquity of the Ecliptic with the Equator, The Ascensional Difference or Cara, The Ahargana and the method of computing the Mean Longitudes of Planets. **(25 Lectures)**

Planetary Theories. Eccentric model, Epicyclic model, The planetary schemes, The size of the Sun, and the Moon, Their distance from the Earth, Eclipses and Parallax, The Diameters of the Sun and the Moon and their distance from the Earth, calculation of the Length and the Diameter of the Earth's Shadow, Condition of Eclipses. Aryabhatta planetary laws vis-à-vis Kepler's law of planetary motion. **(25 Lectures)**

Astronomical Instruments. The Water clock or Clepsydra, The Gnomon (Sanku), The Cakra or Circle, Capa, Dhanu, Kartari, Turiya, The Armillary Sphere (Gola Yantra), The Astrolabe, Masonry Instruments. **(10 Lectures)**

Reference Book:

1. A Concise History of Science in India by D. M. Bose, S.N. Sen & B.V. Subbarayappa
2. Kapil Kapoor – Text and Interpretation: The Indian Tradition
3. Subhash Kak – The Astronomical Code of the Rigveda
4. Debiprasad Chattopadhyaya – History of Science and Technology in Ancient India
5. S. R. Sarma – Indian Mathematics and Astronomy
6. K.S. Shukla & D. Sen – History of Science, Philosophy and Culture in Indian Civilization

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II. SKILL ENHANCEMENT COURSE - A [ECPHY312A]
NUMERICAL METHODS & SIMULATION

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

(Credits: Theory-04, 60 Hours)

Course Objectives:

1. To familiarize students with various numerical methods and their applications.
2. To understand the Monte-Carlo technique and other modelling and simulation methods and their use in numerical solutions and computations.

Course Learning Outcomes:

1. Understanding of different numerical methods and their applications, like Newton-Raphson method, Direct method, Gauss-Jordon elimination method, Picard's method, Euler's method, quadrature, trapezoidal and Simpson's rule, Runge-Kutte methods, Rayleigh-Ritz method, and so on.
2. Be able to perform Monte-Carlo operations, simulations using SCILAB / MATLAB / PYTHON / SIMULINK/ PSpice / LT Spice / LabView / ORCAD, etc. for various scholarly and research problems.

Contents:

Solution of Linear System: Numerical solution of algebraic equation, Iteration, Newton Raphson method, Solution of Linear system, Direct method, Gauss, Gauss-Jordon elimination method, Matrix inversion and LU decomposition, Eigenvalues and Eigenvectors, Applications. **(10 Lectures)**

Interpolation, Lagrange approximation, Newton and Chebyshev Polynomials, least square fitting, Application in some physical problems. **(10 Lectures)**

Numerical Differentiation and Integration: Numerical solution of ordinary differential equation, Iteration method, Picard's method, Euler's method and improved Euler's method. Introduction to quadrature, trapezoidal and Simpson's rule Applications. **(10 Lectures)**

Numerical Solution of Partial Differential Equations: First and second order, Linear and non-linear differential equations, Solution by method of iteration, Euler and Runge Kutte methods. Finite difference method, Relaxation, Fourier and cyclic reduction and the Rayleigh-Ritz method, Application to diffusion of dopant in a semiconductor, Wave equation in a coaxial cable, Vibrating strings and membranes, Poison equation, Schrodinger equations. **(15 Lectures)**

Monte Carlo Technique: Evaluation of single and multi-dimensional integrals, Optimization problems, Applications to statistical mechanics, Metropolis algorithm. **(05 Lectures)**

Simulation/ Modelling: Concept of modelling, Introduction to techniques of modelling, State variable model of system, Model parameters and simulation using SCILAB / MATLAB / SIMULINK, Time domain and frequency domain analysis of systems using SCILAB / MATLAB, Spice modelling of semiconductor devices (p-n diode and BJT) and programming methodology, Circuit simulation using Pspice / LabView / ORCAD **(10 Lectures)**

Basic programming concepts using Scilab/Matlab to solve the problems based on the following:

1. Interpolation and extrapolation: Least Square Fitting.
2. Solution of simultaneous equation: Polynomial equation, Polynomial equation fitting.
3. Matrix manipulations, Matrix inversion, Eigenvalues computations.
4. Numerical integration and differentiation.
5. Ordinary boundary-value problems, Two dimensional problems.
6. Monte Carlo method and its applications, Evaluation of two and three-dimensional integrals.

Books Suggested:

1. Introduction to Numerical Analysis, S.S. Sastry, PHI Learning Pvt. Ltd.
2. Schaum's Outline of Programming with C++., J. Hubbard, McGraw-Hill Pub.
3. Numerical Recipes in C: The Art of Scientific Computing W.H Pressetal, Cambridge University Press.
4. A First Course in Numerical Methods, U.M Ascher& C. Greif, PHI Learning.
5. Elementary Numerical Analysis, K. E. Atkinson, Wiley India Edition.
6. Numerical Methods for Scientists & Engineers, R.W. Hamming, Courier Dover Pub.
7. An Introduction to Computational Physics, T. Pang, Cambridge Univ.
8. Simulation of ODE/PDE Models with Matlab, Octave and Scilab, Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C. V. Fernandez. 2014 Springer.
9. Scilab by Example: M. Affouf 2012, ISBN: 978-1479203444.
10. Scilab (A free Software to Matlab): H. Ramchandran, A.S. Nair. 2011, S. Chand & Company.
11. Scilab Image Processing, Lamberr M.Surhone, 2010 Betascript Publishing.

OR SKILL ENHANCEMENT COURSE - B [ECPHY312B]

EXPERIMENTAL TECHNIQUES

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

(Credits: Theory-04, 60 Hours)

Course Objectives:

1. To understand various experimental techniques and their applications.
2. To perform certain lab work based on the taught experimental techniques.

Course Learning Outcomes:

1. Understanding of experimental techniques like thin film coating, spectroscopic techniques. NMR and EPR, X-ray diffraction, Electron microscopy, etc.
2. Be able to perform thin film coating, spectroscopic analysis, X-ray diffraction analysis, electron microscopy etc.

Contents:

Sensors: Characteristics, Sensitivity, reproducibility, Sensors for displacement, Velocity, acceleration, Strain, Temperature, Pressure, Magnetic field. **(05 Lectures)**

Thin Film Coating: Evaporative coating, DC and plasma sputtering, Laser ablation techniques for measuring thickness of thin film. **(08 Lectures)**

Low Temperatures Techniques: Properties of cryogenic fluids, bath cryostat and continuous flow cryostat, Cryogenic refrigerators, Temperature measurements, a Cryostat for resistivity measurement. **(08 Lectures)**

High Pressure Techniques: High pressure cell for resistivity measurement, Measurement of high pressure, Diamond anvil cell for very high pressure. **(08 Lectures)**

Spectroscopic Techniques: IR absorption to study molecular vibrations and rotations, band gap of semiconductors, superconducting energy gap, Visible and UV absorption for the study of electric energy levels, defects in solids etc. Raman effect for the study of molecular vibrations and vibrations in solids, Main components of spectrometers, Sources, Dispersing element and detector, IR, UV, Visible absorption spectra, Description of Raman spectrometer and Raman spectra. **(08 Lectures)**

NMR and EPR Spectrometers: Principle of operation, Basic components of the spectrometer, Typical NMR and EPR spectra and applications. **(08 Lectures)**

X-ray Diffraction Techniques and Electron Microscope: Principle of x-ray diffraction, Bragg's law and Laue pattern, Powder diffraction method, Transmission and Scanning electron microscopes and applications. **(08 Lectures)**

Surface Probe Techniques: Principle of AFM, STM, MFM and applications. **(07 Lectures)**

Lab Work for this Course: Fabrication of thin film using evaporation and sputtering technique, Raman spectra analysis if a sample, Study of EPR and NMR spectra, Study of X-ray diffraction pattern of powder sample, SEM photograph studies.

Books Suggested:

1. Molecular Spectroscopy, An Introduction, Jagmohan, Narosa Publication.
2. Advanced level Physics Practical, Michael Nelson and Jon M. Ogborn, 4th Edn, Reprint 1985, Heinemann Educational Publishers.
3. Advanced Practical Physics for Students, B. L. Flint & H.T. Worsnop, 1971, Asia Publishing.
4. Introduction to Measurement and Instrumentation, A. K. Ghosh, 3rd Edn., PHI Learning Pvt. Ltd.
5. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edn. 2011, Kitab Mahal, New Delhi.
6. Measurement, Instrumentation and Experiment Design in Physics & Engineering, M. Sayer, and A. Mansingh, 2005, PHI Learning.

III. CORE COURSE [CCPHY313]
ADVANCED NUCLEAR PHYSICS-II

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

(Credits: Theory-04, 60 Hours)

Course Objectives:

1. To study and understand about the working of various nuclear detectors and their applications.
2. To understand the various nuclear reactor mechanisms.

Course Learning Outcomes:

1. Understanding of the construction, working and applications of various solid-state detectors and high-energy detectors and their electronics.
2. Understanding of nuclear fission, neutron diffusion and moderation mechanisms, criticality of reactor and the power reactor.

Contents:

Nuclear Radiation Detectors

Detection: Simple model of detector, energy measurement, position and time measurement.

Solid State Detectors: Semiconductor detectors, Surface barrier detectors, Scintillation counters: Organic and inorganic scintillators, Photomultiplier tubes, Gamma Ray Scintillation Spectrometer.

High Energy Particle Detectors: General principles, Nuclear emulsions, Cloud chambers, Bubble chamber.

Nuclear Electronics: Pulse shaping, Linear amplifiers, Pulse height discriminators, Single channel and Multichannel analyzer. (**20 Lectures)**

Nuclear Reactor Theory

Fundamentals of Nuclear Fission: Fission fuels, Prompt and delayed neutrons, Chain reaction, Multiplication factor, Condition for criticality, Breading phenomena. **(8 Lectures)**

Diffusion of neutrons: Neutron current density, The equation of continuity, Fick's law, The diffusion equation, Measurement of diffusion parameters. (**8 Lectures)**

Neutron Moderation: Moderation without absorption, Energy loss in elastic collisions, Average logarithmic energy decrement, slowing down power and moderating ratio of a medium. Slowing down densities, Moderation- Space dependent slowing down, Fermi's age theory, Moderation with absorption (**9 Lectures)**

Criticality of an Infinite Homogenous Reactor: The critical equation, Optimum reactor shapes, Material and geometrical bucklings, Neutron balance in a thermal reactor, Four factor formula, Calculation of critical size and composition in simple cases. (**10 Lectures)**

Power Reactor: Fast breeder reactors, Thermo-nuclear reaction, nuclear fusion in stars, Concept of fusion reactor. (**05 Lectures)**

Books Suggested:

1. Elements of Nuclear Physics, Nikhil Ranjan Roy & Rakesh Kumar Pandey, Atlantic P & D, 1/e, 2024
2. Segre, E., "Experimental Nuclear Physics", John Wiley
3. Singru, R.M., "Introduction to Experimental Nuclear Physics", John Wiley & Sons, 1974.
4. W.R. Leo, "Techniques for Nuclear and Particle Physics Experiments"
5. Kapoor S.S and Ramamurthy V.S., "Nuclear Radiation Detectors", New Age International Publishers 1986.
6. Syed Naeem Ahmed, "Physics and Engineering of Radiation Detection", Academic Press, Elsevier, 2007.
7. Glasstone, S. and Edlund, M. C., "The Elements of Nuclear Reactor Theory", Van Nostrand Co., 1953.
8. Stacey, W. M., "Nuclear Reactor Physics"
9. Lamarsh, J. R., "Introduction to Nuclear Reactor Theory', Addison Wesley, 1966
10. Murray, L., "Introductions of Nuclear Engineering".
11. Varma, J. "NUCLEAR Physics Experiments", New Age International Publishers 2001.
12. Singru, R.M., "Introduction to Experimental Nuclear Physics" Wiley Eastern Pvt. Ltd.

IV. CORE COURSE [CCPHY314]
STATISTICAL PHYSICS

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

(Credits: Theory-04, 60 Hours)

Course Objectives:

1. To understand quantum ensemble and quantum statistics.
2. To understand the properties of imperfect gases and high-density gases, and the non-equilibrium statistical mechanics.

Course Learning Outcomes:

1. Understanding of quantum ensemble theory and quantum statistics and its real-world applications.
2. Understanding of phase transitions, and the properties of imperfect gases and high-density gases, Chandrasekhar mass limit, White dwarf and neutron stars.

Contents:

Quantum Ensemble Theory: Micro-canonical Canonical and Grand Canonical ensembles, Phase space, Distribution functions, Partition function and relationship to thermodynamic quantities, Fluctuations in energy, particle density, Pressure and volume, Equivalence of ensembles. (**10 Lectures)**

Quantum Statistics: Equation of state of ideal Fermi and Bose gases, Degenerate electron gas and specific heat, Degenerate Bose gas, Bose-Einstein condensation, Evaluation of constant α and β and its thermodynamics interpretation, Thermal properties of Bose- Einstein and liquid He 4, the Lambda transition, two fluid model, Black body distribution law. Density matrix and classical limit for N-particles partition function. (**12 Lectures)**

Imperfect Gases: Classical and Quantum cluster expansion, Virial equation of state, Virial coefficients in classical limit, Second Virial coefficients for hard-sphere and square-well potentials. (**9 Lectures)**

Phase Transitions: Ising model, Bragg-Williums Approximation, Mean field theories of the Ising model in three, two and one dimensions, Exact solutions in one dimension, Landau theory of phase transition, Critical indices, Scale transformation and dimensional analysis. (**9 Lectures)**

High-Density Gases: Thermo-ionic and photoelectric emission, Spin Para-magnetism, Landau Diamagnetism, Equation of state at very high density, Equilibrium of bodies of large mass, Chandrasekhar mass limit, White dwarf and neutron stars. (**10 Lectures)**

Non-Equilibrium Statistical Mechanics: Boltzmann Transport equation, Boltzmann H-theorem, Equations of motion in classical mechanics, Time correlation function, Linear response theory,
Electrical conduction, Langevin equation and Brownian motion, Debye theory of dielectric relaxation. Motion due to fluctuating force. The Fokker-Planck Equation, Solution on Fokker-Planck Equation. (**10 Lectures)**

Books Suggested:

1. Sinha, S.K., “Statistical Mechanics”,
2. Kerson & Huang, “Statistical Mechanics”,
3. Friedman, H.L., “A Course in Statistical Mechanics”,
4. McQuarrie, D.A., “Statistical Mechanics”,
5. Landau, L, & Liefshitz, “Statistical Mechanics”, Pergaman Press.
6. Statistical Mechanics, R. K. Patharia, Bufferworgh Heinemann
7. Fundamental of Statistical and Thermal Physics, F. Rief, McGraw Hill International Edition.
8. Fundamental of Statistical Mechanics, B.B. Laud, New Age International Pub.
9. R. K. Srivastava & J. Ashok, “Statistical Mechanics”.
10. Hill, T.L., “Statistical Mechanics”,
11. Gupta & Kumar, “Statistical Mechanics”,
12. Agrawal, B.K., Statistical Mechanics.
13. Prakash Satya & Agrawal J.P., “Thermodynamics Statistical Physics & Kinetics”

I. CORE COURSE [CPPHY315]
PRACTICAL

Marks: 30 (MSE: 20 Viva + 5 Attd. + 5 Record) + 70 (ESE Pr: 6 Hrs) = 100	Pass Marks = 45

(Credits: Practical-04, 120 Hours)

Instruction to Question Setter:
End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

Practicals:
1. Frank Hertz Experiment.
2. Experiment with Hall apparatus.
3. Four-Probe set up for mapping the resistivity of large sample.
4. Measurement of magneto resistance of semiconductor sample.
5. Measurement of Susceptibility of paramagnetic solution by Quinke's tube method.
6. Study of the energy band gap and diffusion potential of p-n junction.
7. Study of Multivibrator.
8. Study of Characteristics of Semiconductor diodes: Si, Ge, Zener and LED.
9. Study of an Integrated Circuit Regulator.
10. Two Probe method for resistivity measurement of insulators at different temperatures

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SEMESTER II

I. ELECTIVE COURSE-A [ECPHY411A]

NANOPHYSICS AND NANOMATERIALS-I

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

(Credits: Theory-04, 60 Hours)

Course Objectives:

1. To understand the physics of nanomaterials.
2. To gain deeper knowledge of the various synthesis and characterization methods of nanomaterials.

Course Learning Outcomes:

1. Understanding of the nanomaterials, dimensionalities, optical and transport properties, QHE, and principles and applications of scanning tunnelling microscopy.
2. Understanding of nanomaterial synthesis methods, like ball milling, chemical method, Co-precipitation technique, Sol-gel method, soft chemical technique, CVD, MOCVD, MBE, etc.
1. Understanding of nanomaterial characterization techniques like XPS, SEM, TEM, STM, various others.

Contents:

Nanophysics: Introduction to nanophysics and quantum size effect, Dimensionalities and density of states, Optical and transport properties of two-dimensional electron gas formed at heterostructures and within novel grapheme monolayers with internal folds, Quantum Hall effects, Physics of one-dimensional electron systems including carbon nanotubes and semiconductor nanowires, Fundamental Physics of zero-dimensional electron system, Single electron effects, Quantum dots and nanocrystals, Fundamental principles and applications of scanning tunnelling microscopy in the study of nanophysics. (**20 Lectures)**

Synthesis of Nanomaterials: Top down and Bottom up approach, Synthetic procedures and their significance, Types of nanomaterials synthesis processes, Photolithography, Advanced Ceramics (Solid State reaction method), Ball milling method, Chemical method, Co-precipitation technique, Sol-gel method, Soft chemical technique (citrate, tartarate, etc.), Hydrothermal method, Bio-chemical method, Thin film technology, Thermal Evaporation method, Sputtering (RF and DC), Spray pyrolysis method, Spin coating method, Pulsed laser deposition method, Vacuum arc discharge, Chemical vapor deposition method (CVD), MOCVD, MBE, Ion beam deposition, Electron-beam lithography. MBE growth of quantum dots. (**25 Lectures)**

Characterization Technique: Introductory remarks, Structural, X-ray and neutron diffraction, XPS, Electron beam techniques, Scanning Electron Microscope, Transmission Electron Microscope, Scanning Tunnelling Microscope, Atomic Force Microscope, Photo luminescence Cathodo-luminescence, Electro-luminescence, UV-visible and Fourier transformed infrared spectrophotometry, Thermal analysis, Thermogravimetry analysis, Differential Scanning Calorimeter, Dielectric and Impedance analysis, Magnetic measurements. (**15 Lectures)**

Books Suggested:

1. C. P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.)
2. S. K. Kulkarni, Nanotechnology, Principle & Practices (Capital Publishing Company).
3. K. K. Chatopadhyay and A. N. Banerjee, Introduction to Nanoscience& Technology, PHI
4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
5. M. Hosokawa, K. Nogi, M. Natia, T. Yokoyama, Nanoparticle Tech.Handbook (Elsevier, 2007)
6. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004)

OR ELECTIVE COURSE-B [ECPHY411B]

ELECTRONICS AND COMMUNICATION-I

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

(Credits: Theory-04, 60 Hours)

Course Objectives:

1. To develop an overall understanding of op-amp and its various important applications
2. To understand various electronic logic families and their applications.
3. To study about different types of antennae, configurations and their applications
4. To understand the basics of radar and satellite communication.

Course Learning Outcomes:

1. Understanding of applications of op-amp like, IA, NIC, inductance simulation, precision rectification, converters, etc.
2. Understanding and usage of current conveyor and logic families based on BJT and MOS.
3. Understanding of antenna, radar systems and satellite communications.

Contents:

Operational Amplifier: Operational amplifier (op amp) types, salient features, parameters and modelling, Voltage op-amp based circuits such as:

- Instrumentation amplifier (IA)
- Negative impedance converter (NIC)
- Inductance simulation
- Precision rectification
- Active Butterworth low pass, high pass and band pass 2^{nd} order filters
- Simulation of differential equations
- Analog multiplier and its use in integer power generation, frequency multiplication, divider and generation of fractional powers
- D/A and A/D converters **(15 Lectures)**

Current Conveyor: Current conveyor types, their salient features, modelling and simple applications in realizing bandwidth independent gain amplifier, Current conveyor-based differentiator, integrator, adder and instrumentation amplifier, Advantages of current conveyor-based circuits over the conventional voltage op-amp based circuits. **(08 Lectures)**

BJT Logic Families: TTL logic NAND gate circuit, ECL logic OR/NOR gate circuit, analysis and evaluation of logic parameters. **(05 Lectures)**

MOS Logic Families: NMOS inverter circuit and its analysis with linear and non-linear loads, CMOS inverter. **(05 Lectures)**

Antenna: Antenna action, Short electric doublet, Linear array of n isotropic sources of equal amplitude and spacing, Broad-side array, Ordinary end-fire array, End fire array with increased directivity, Beam width of the main lobe, Yagi antenna, Resonant and non-resonant array arrangement. **(15 Lectures)**

Radar: Basic arrangement of radar system, Azimuth and range measurement, Operating characteristics of a radar system, Derivation of radar range equation. **(6 Lectures)**

Satellite Communication: Orbital and geostationary satellites, Orbital patterns, Look angles, Satellite system, Link modules. **(6 Lectures)**

Books Suggested:

1. A first course in Electronics, A. A. Khan & K. K. Dey, Prentice Hall India.
2. Basic Electronics, Arun Kumar, Bharati Bhawan
3. Millman & Brabel, "Microelectronics", McGraw-Hill (International Students' Edition).
4. Mitchell & Mitchell, "Introduction to Electronics Design", Prentice-Hall of India.
5. Nagrath, "Electronics: Analog and Digital", Prentice-Hall of India.
6. Soclof, "Design and Applications of Analog Integrated Circuits", Prentice-Hall of India.
7. Gayakwad, "Op-Amps and Linear Integrated Circuits",3 /e, Prentice-Hall of India
8. Sedra& Smith, "Microelectronic Circuits", 3/e, Sounders College Publishing.
9. Microwave and Radar Engineering Kulkarni, Umesh Publication.
10. Electromagnetic Waves and Radiating Systems: Jordan, PHI
11. Hand Book of Electronics, Gupta & Kumar, Pragati Prakashan, Meerut.
12. Electronics Communications: Roddy Coolen, PHI
13. Electronic Communication: Kennedy & Davis, TMH

OR ELECTIVE COURSE-C [ECPHY411C]

CONDENSED MATTER PHYSICS-I

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

Course Objectives:

1. To explore the physics behind different experimental techniques used in condensed matter physics, and that of x-ray diffraction and crystal structure.
2. To understand the finer details of magnetism, fermi surface and phonons.

Course Learning Outcomes:

1. Understanding of experimental techniques like, Weissenberg and Precession methods, The Diffractometer, Area Detector and Image Plate, etc.
2. Understanding of physics behind the x-ray diffraction and crystal structures.
3. Understanding of magnetism in details including Hund's rule, Curies law, Ising model, Bragg-William approximation

Contents:

X-ray Diffraction Theory: Coherent and incoherent scattering, Derivation of Laue equations and expression for structure factor, Data reduction. **(08 Lectures)**

Crystal Structure Determination: The phase problem in crystallography, Electron density as Fourier transform of structure factor and vice versa, Techniques to solve the phase problem –
Fourier and Patterson methods, Heavy atom technique, The Single Isomorphous Replacement (SIR) and Multiple Isomorphous Replacement (MIR) techniques, Anomalous scattering technique, Direct methods. **(15 Lectures)**

Experimental Techniques: The Weissenberg and Precession methods, The Diffractometer, Area Detector and Image Plate. **(7 Lectures)**

Fermi Surface: Construction of Fermi surface, Zone schemes, Electron, hole and open orbits, Cyclotron resonance. *Determination of Fermi surface* – Quantization of orbits in magnetic field; de-Hass – van-Alfen effect; External orbits; Outline of other methods. **(10 Lectures)**

Phonons: *Harmonic crystals,* Crystal potential; Harmonic and adiabatic approximations; Normal modes and phonons; Phonon spectrum by neutron scattering; Crystal momentum. *Anharmonic crystals,* Anharmonicity, Lattice thermal conductivity, Umklapp process; Second sound. **(8 Lectures)**

Magnetism: Interaction of solids with magnetic fields, Magnetization density and susceptibility, Calculation of atomic susceptibility, Susceptibility of insulators (Larmor diamagnetism), Ground state of ions with partially filled shells (Hund's rule), van Vleckpara magnetism, Curie laws for free ions and solids, Pauli paramagnetism, Conduction electron diamagnetism, Exchange interaction, Ferromagnetic domains, Anisotropy energy, Thickness and energy of Bloch walls, Ising model, Bragg-Williams approximation, Solution of Ising problem for a linear chain. **(12 Lectures)**

Books Suggested:

1. Philips, "An Introduction to Crystallography",
2. Woolfson, M.M., "An Introduction to X-ray Crystallography",
3. International Tables for X-ray Crystallography, Vol. I
4. Verma, A. R. & Krishna, P., "Polymorphism and Polytypism",
5. Kittel, C., "Solid-State Physics",
6. Raghavan, V., "Material Science and Engineering".
7. Aschrof, N.W. and Mermin, N. D., "Solid-State Physics".
8. Bunger, M.J., "Crystal Structure Analysis".
9. Bunger, M.J., "X-ray Crystallography".
10. Staut & Jenson, "A Practical Guide to X-ray Crystal Structure Determination"

II. ELECTIVE COURSE-A [ECPHY412A]
NANOPHYSICS AND NANOMATERIALS-II

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

(Credits: Theory-04, 60 Hours)

Course Objectives:

1. To understand the physics and applications of various properties of nanomaterials.
2. To discuss the details of various applications of nanomaterials.

Course Learning Outcomes:

1. Understanding of optical, electronic and magnetic properties of nanomaterials.
2. Understanding of nanomaterials-based applications like LED, CNT, NEMS, SQUIDS, quantum dots, etc.

Contents:

Optical Properties: Coulomb interaction in nanostructures, Concept of dielectric constant for nanostructures and charging of nanostructure, Quasi-particles and excitons, Excitons in direct and indirect band gap semiconductor Nano-crystals, Quantitative treatment of quasi-particles and excitons, charging effects, Radiative processes, General formalization, absorption, emission and luminescence, Optical properties of hetero-structure and nanostructures. **(16 Lectures)**

Electron Transport: Electrical properties of polymers, ceramics, dielectrics, amorphous materials, electrical conduction in metals, Alloys and semiconductors, band structure, carrier transport in nanostructures, Coulomb blockade effect, thermionic emission, tunnelling and hoping conductivity, Defects and impurities, Deep level and surface defects. **(16 Lectures)**

Magnetic Properties of Materials: Classification of magnetic materials, Magnetic materials of technical importance, Magnetization processes, Super-paramagnetism, Magnetic domain structure, Superconductivity, Phenomenology of superconductivity. **(10 Lectures)**

Applications: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, Solar Cells). Single electron devices (no derivation). CNT based transistors. Nanomaterial Devices, Quantum dots hetero-structure lasers, optical switching and optical data storage. Magnetic quantum well, magnetic dots – magnetic data storage, Micro Electromechanical systems (NEMS), Nano, Electromechanical Systems (NEMS). Integrated optical devices, SQUIDS, Spintronic devices, Ferroelectric, Pyro-electric, Piezoelectric and electro-optic devices. **(18 Lectures)**

Books Suggested:

1. C. P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.)
2. S. K. Kulkarni, Nanotechnology, Principle & Practices (Capital Publishing Company).
3. K. K. Chatopadhyay and A. N. Banerjee, Introduction to Nanoscience& Technology, PHI
4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
5. M. Hosokawa, K. Nogi, M. Natia, T. Yokoyama, Nanoparticle Tech.Handbook (Elsevier, 2007)
6. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004)

OR ELECTIVE COURSE-B [ECPHY412B]

ELECTRONICS AND COMMUNICATION-II

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

(Credits: Theory-04, 60 Hours)

Course Objectives:

1. To study the physics behind the transmission of electromagnetic wave through different transmission channel.
2. To understand the detail architectural details of microprocessor and its application.

Course Learning Outcomes:

1. Understanding of transmission lines, waveguides and optical fiber as transmission channel for electromagnetic wave.
2. Understanding of finer details of microprocessor, addressing mode, instruction set, interrupts, memory access, etc.

Contents:

Transmission Line: Types of transmission line, distributed parameters, voltage and current relations on a radio frequency transmission line with respect to sending and receiving ends, propagation constant (γ), attenuation constant (α) and phase constant (β), expressions for α and β, transmission line distortion and attenuation, conditions for no distortion, low distortion and low loss, line termination across a short circuit, open circuit pure resistance and complex impedance, quarter wave and half wave lines and their impedance matching properties. **(16 Lectures)**

Wave Guide: Field expression for propagating TE and TM waves in hollow circular cylindrical wave guides, Impossibility of TEM waves in hollow wave guide, Attenuation in wave guides and Q-factor. **(8 Lectures)**

Fiber Optic Communication: Principle of light transmission in a fiber. Light sources for fiber optic communication, Effect of index profile on propagation, Modes of propagation, Number of modes a fiber may support, Single mode fiber (SMF), Losses in fibers. **(12 Lectures)**

Microprocessor Architecture: 8085 Microprocessor Architecture, Real Mode and protected modes of memory addressing, memory paging.

Addressing Modes: Data addressing modes, Program memory addressing modes, stack memory addressing modes.

Instruction Set: Data movement instructions, arithmetic and logic instructions, Program control instruction, Assembler details.

Interrupts: Basic interrupt processing, Hardware interrupt. Expanding the interrupt structure 8259A PIC.

Direct Memory Access: Basic DMA operation, 8237 DMA controller, Shared Bus operation Disk Memory systems. **(24 Lectures)**

Books Suggested:

1. Miah, “Fundamentals of Electromagnetic”, TMH
2. Mano, “Computer System Architecture”, Prentice-Hall of India.
3. Goankar, Microprocessors Architecture, Programming & Applications with 8085,
4. Senior, “Optical Fiber Communications: Principles and Practice”, 2/e, Prentice-Hall.
5. Jordon &Balmain, “Electromagnetic waves and Radiating Systems”, Prentice-Hall of India.

OR ELECTIVE COURSE-C [ECPHY412C]

CONDENSED MATTER PHYSICS-II

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	**Pass Marks: (MSE: 17 + ESE: 28) = 45**

(Credits: Theory-04, 60 Hours)

Course Objectives:

1. To understand various condensed matter mechanism and their applications.
2. To understand the physics behind the phenomenon of superconductivity, thin films and dielectrics.

Course Learning Outcomes:

1. Understanding of phase transformation, Dielectrics, ESR, NMR and their applications.
2. Understanding of detail theories and applications of superconductor, viz. BCS theory, Cooper pairs, London equation, Josephson effects, Critical fields and moments, etc

Contents:

Phase Transformation and Diagrams: phase rule, single component system, Binary phase system, lever rule, Nucleation and growth, Nucleation kinetics, Growth and overall transformation kinetics and applications to steel and glass. (**8 Lectures)**

ESR: basic theory, relaxation mechanism, Effect of spin-orbit coupling and crystal fields on g values, Fine and hyperfine structures, Ferromagnetic resonance (FMR), General features of FMR, Shape effect in FMR, Antiferromagnetic resonance. (**8 Lectures)**

NMR: Basic theory, Spin lattice relaxation, Bloch equation and their steady state solutions, General features of NMR spectra, Chemical shifts, Fine structure due to spin-spin coupling, Application to molecular structure and bondings. (**8 Lectures)**

Superconductivity: BCS theory of superconductivity, Cooper pairs, superconducting ground state, Flux quantization in superconducting ring, Quasi-particles and energy gaps, Temperature dependence of energy gaps, London equation, Coherence length, Persistent current, Single particle tunnelling, Josephson tunnelling, Josephson effects (AC and DC), Microscopic quantum interference, Qualitative idea of high temperature superconductors, Critical fields and moments. (**12 Lectures)**

Thin Films: Deposition techniques, thermal, electron and sputtering methods, metallic semiconductor and insulator thin films and their electrical, electronic and optical properties. Magnetic superconducting thin films and applications. (**12 Lectures)**

Dielectrics: Structure of dielectrics, Polarization mechanism, Effect of temperature and frequency. Effect of conduction (ionic and electronic) in dielectrics, Dielectric losses and breakdown, Electrets and MIM. (**12 Lectures)**

Books Suggested:

1. Crystallography - Philips
2. Solid State Chernistry-Garner (Butterworth; London)
3. Solid State Chemistry -D. K. Chakraborty (New Age int Publication)
4. Solid State Chemistry- N. B. Hannay (Prentice Hall, New Jersay)
5. Physical Chemistry- Waller J. Moore
6. Principles of polymer chemistry, Cornell, P. J. Flory (Univ. Press)
7. Handbook of Conducting Polymers, Vol I & II" T A. Skolhia

III. CORE COURSE [CCPHY413]
ATMOSPHERIC PHYSICS

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

(Credits: Theory-04, 60 Hours)

Course Objectives:

1. To develop an acquaintance with Earth's atmosphere and its dynamics.
2. To study about the atmospheric waves, aerosols, and various tools for atmospheric waves.

Course Learning Outcomes:

1. Understanding of earth's atmosphere, meteorological processes and different systems, fronts, Cyclones and anticyclones, thunderstorms. And its dynamics involving basic conservation laws, circulations, vorticity, oscillations, etc.
2. Understanding of processing tools for atmospheric waves like, RADAR, LIDAR, AGW, etc.
3. Understanding of atmospheric aerosols and their implications including Rayleigh scattering and Mie scattering, Bouguert-Lambert law, Principles of radiometry, etc.

Contents:

General features of Earth's atmosphere: Thermal structure of the Earth's Atmosphere, Ionosphere, Composition of atmosphere, Hydrostatic equation, Potential temperature, Atmospheric Thermodynamics, Greenhouse effect and effective temperature of Earth, Local winds, monsoons, fogs, clouds, precipitation, Atmospheric boundary layer, Sea breeze and land breeze. Instruments for meteorological observations, including RS/RW, meteorological processes and different systems, fronts, Cyclones and anticyclones, thunderstorms. **(12 Lectures)**

Atmospheric Dynamics: Scale analysis, Fundamental forces, Basic conservation laws, The Vectorial form of the momentum equation in rotating coordinate system, scale analysis ofequation of motion, Applications of the basic equations, Circulations and vorticity, Atmospheric oscillations, Quasi biennial oscillation, annual and semi-annual oscillations, Mesoscalecirculations, The general circulations, Tropical dynamics. **(12 Lectures)**

Atmospheric Waves: Surface water waves, wave dispersion, acoustic waves, buoyancy waves, propagation of atmospheric gravity waves (AGWs) in a nonhomogeneous medium, Lamb wave, Rossby waves and its propagation in three dimensions and in sheared flow, wave absorption, non-linear consideration. **(12 Lectures)**

Atmospheric Radar and Lidar: Radar equation and return signal, Signal processing and detection, Various type of atmospheric radars, Application of radars to study atmospheric phenomena, Lidar and its applications, Application of Lidar to study atmospheric phenomenon. Data analysis tools and techniques. **(12 Lectures)**

Atmospheric Aerosols: Spectral distribution of the solar radiation, Classification and properties of aerosols, Production and removal mechanisms, Concentrations and size distribution, Radiative and health effects, Observational techniques for aerosols, Absorption and scattering of solar radiation, Rayleigh scattering and Mie scattering, Bouguert-Lambert law, Principles of radiometry, Optical phenomena in atmosphere, Aerosol studies using Lidars. **(12 Lectures)**

Reference Books:

1. Fundamental of Atmospheric Physics – Murry L Salby; Academic Press, Vol 61, 1996
2. The Physics of Atmosphere – John T. Houghton; Cambridge University press;3rd edn. 2002.
3. An Introduction to dynamic meteorology – James R Holton; Academic Press, 2004
4. Radar for meteorological and atmospheric observations – S Fukao and K. Hamazu, SpringerJapan, 2014

IV. ELECTIVE COURSE-A [EPPHY414A]
PRACTICAL-A

Marks: 30 (ESE: 20 Viva + 5 Attd. + 5 Record) + 70 (ESE Pr: 6 Hrs) = 100	Pass Marks = 45

(Credits: Practical-04, 120 Hours)

Instruction to Question Setter:
End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

Practicals:

1. Synthesis of metal nanoparticles by chemical route.
2. Synthesis of semiconductor nanoparticle.
3. Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer.
4. XRD pattern of nanomaterials and estimation of particle size.
5. To study the effect of size on colour of nanomaterials.
6. To prepare composite of CNTs with other materials.
7. Growth of quantum dots by thermal evaporation.
8. Prepare a disc of ceramic of a compound using ball milling, pressing and sintering and study its XRD.
9. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.
10. Prepare a thin film capacitor and measure capacitance as a function of temperature or frequency.
11. Fabricate a PN diode by diffusing Al over the surface of N-type Si and study its V-I characteristic.

OR ELECTIVE COURSE-B [EPPHY414B]

PRACTICAL-B

Marks: 30 (ESE: 20 Viva + 5 Attd. + 5 Record) + 70 (ESE Pr: 6 Hrs) = 100	**Pass Marks = 45**

(Credits: Practical-04, 120 Hours)

Instruction to Question Setter:

End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

Practicals:

1. Operational amplifier parameters measurements and their dependence on frequency.
2. Basic operational amplifier configurations: inverting amplifier, non-inverting amplifier, voltage follower, differentiator, integrator and instrumentation amplifier.
3. Butterworth second order active low pass and high pass filters.
4. Studies on second order band-pass and band-elimination active filters.
5. Design and study of Wein bridge oscillator circuit.
6. Design and study of op amp based square wave oscillator.
7. To draw the characteristic curve of SCR and to determine its holding voltage, holding current and break-over voltage
8. Use of IC 555 timer.
9. To simulate electronic circuits using PSpice.
10. BCD adder and subtractor.
11. Precision rectification: half- and full- wave.
12. DIAC and TRIAC characteristics and applications.
13. Studies on the polar pattern of microwave transmitting horn antenna.
14. Familiarity with microwave components, microwave propagation in hollow rectangular wave-guide and measurement of dielectric constant in X-band.
15. Amplitude modulation and demodulation.
16. Studies on Phase Locked Loop (PLL) IC 565 and its use in frequency multiplication.
17. Design, construct and test electronically regulated power supplies using Zener diode, 3-pin regulators (78xx/79xx) and IC 723.
18. Design and study of the characteristics of TTL logic NAND gate and the evaluation of its parameters.

OR ELECTIVE COURSE-C [EPPHY414C]
PRACTICAL-C

Marks: 30 (ESE: 20 Viva + 5 Attd. + 5 Record) + 70 (ESE Pr: 6 Hrs) = 100	**Pass Marks = 45**

(Credits: Practical-04, 120 Hours)

Instruction to Question Setter:
End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

Practicals:

1. Studies on semiconductors: 4-Probe method for the determination of band gap and the dependence of resistivity on temperature.
2. Hall Effect study: Hall co-efficient, carrier concentration and carrier mobility.
3. Electrical properties of thin film samples.
4. ESR study.
5. Determination of magnetic parameters of some minerals using hysteresis loop tracer.
6. Crystal structure analysis using 3D – X-ray diffraction data (Data supplied).
    a. Use of heavy atom technique.
    b. Use of Direct Methods.
    c. Computation of 3 –D Fourier and its interpretation.
    d. Computation of Bond length, bond angle and H-bond & other geometrical parameters of known structures.
7. (e) ORTEP plot of molecule.
8. Determination of polarazibality of sugar solution.
9. Determination of magnetic susceptibility using Guoy's method.
10. Determination of Curie temperature by dielectric constant apparatus.
11. Determination of modulus of rigidity and internal friction by modulus of rigidity apparatus.
12. Study of impedance spectrometry of a given sample using LCR meter.
13. Study of temperature dependence of Hall coefficient.
14. Synthesis of materials under different stoichiometric ratio.
15. Study of absorption pattern of a given sample using FTIR spectrometer.

V. PROJECT [PRPHY415]

DISSERTATION/ PROJECT/ TEACHING APTITUDE

Marks: 30 (MSE: 20 Viva + 5 Attd. + 5 Record) + 70 (ESE Pr: 6 Hrs) = 100	Pass Marks: = 45

(Credits: 04, 120 Hours)

Guidelines to Examiners for
End Semester Examination (ESE):

The evaluation of the dissertation will be done in 100 marks (70 marks + 30 marks of the session). The sessional component will be evaluated by the concerned supervisor.

The end term evaluation (70 marks) will be done by a board of examiners. The end term evaluation in 70 marks will include the literary and scientific presentation of the dissertation and the performance in the viva-voce.

Overall project dissertation may be evaluated under the following heads:

- *Motivation for the choice of topic*
- *Project dissertation design*
- *Methodology and Content depth*
- *Results and Discussion*
- *Future Scope & References*
- *Participation in Internship programme with reputed organization*
- *Application of Research technique in Data collection*
- *Report Presentation*
- *Presentation style*
- *Viva-voce*

PROJECT WORK

Each student **must** submit two copies of the dissertation work duly forwarded by the **Head of the Department and duly signed by the supervisor concerned.** The forwarded copies will be submitted in the University Department of Physics, Ranchi University, for evaluation (Seven days before the seminar).

The paper will consist of

a. Field work/Lab work related to the project.
b. Preparation of dissertation based on the work undertaken.
c. Presentation of project work in the seminar on the assigned topic in the P.G. Department of Physics, Ranchi University, Ranchi & open viva there on.

Topics: Each student shall have to complete a project work on any topic of his choice, but relevant to the frontier area of Science and Technology, or on a topic allotted by his/her Project Guide/Supervisor/Department in Semester -IV. This is compulsory and the candidates shall ensure that his project is on a relevant topic completed by him independently with the help and inputs from his/her guide/supervisor. Other guidelines pertaining to this paper shall be provided by the department.

Teaching Aptitude: Only selected candidates, in alternative to the Dissertation, may be provided duty to teach the assigned topics in selected colleges. The performance may be evaluated based on the organized feedback for the candidate.

NB:- Students will select topics for the project work in consultation with a teacher of the department.
The Seminar will be held in the University Department of Physics, Ranchi University, Ranchi.
