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BENGALURU
CITY UNIVERSITY

Office of the Registrar, Central College Campus, Dr. B.R. Ambedkar Veedhi, Bengaluru – 560 001.
PhNo.080-22131385, E-mail: registrarbcu@gmail.com

No.BCU/Ph.D-Syllabus /47 /2025-26 Date. 02.05.2025

NOTIFICATION

Sub: Course Work Syllabus of Ph.D in Physics of Bengaluru City University

Ref: 1. The recommendations of the Board of Studies in Physics (PG)
2. Approval of the Vice-Chancellor dated.02.05.2025

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In pursuance to the recommendations of the Board of Studies in Physics (PG) and pending approval of the Academic Council, the Course Work Syllabus of Ph.D in Physics of Bengaluru City University with is hereby notified for information of the concerned. Effective from the academic year 2025-26

The copy of the Syllabus is notified in the University Website: www.bcu.ac.in for information of the concerned.

REGISTRAR

To,

1. The Dean, Faculty of Science, BCU.
2. The Chairman & Members of BOS in Physics (PG), BCU.
3. The Principals of the concerned affiliated Colleges of BCU – through email.
4. The P.S. to Vice-Chancellor/Registrar/Registrar (Evaluation), BCU.
5. Office copy / Guard file.

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BE BOUNDLESS

Bangalore City University

Department of Physics

Central College Campus

Bengaluru – 560 001

Syllabus

for

PhD course work in Physics

(Effective from the Academic Year 2025-26)

Ph.D. Course Work Syllabus-2025
(Scheme: PhD-CW-2025)

Paper I: Ph.D. Phy 101
Research Methodology
(Teaching Hours: 3 Hours per week, Max Marks: 100, Credits: 04)

Unit -I: Research Methodology: An Introduction

Meaning of Research; Objectives of Research; Motivation in Research; Types of Research; Research Approaches; Significance of Research; Research Methods versus Methodology; Research and Scientific Method; Importance of Knowing How Research is Done; Research Process; Criteria of Good Research; Problems Encountered by Researchers in India **16 hours**

Unit II: Defining the Research Problem

Review of literature; What is a Research Problem? Selecting the Problem; Necessity of Defining the Problem; Technique Involved in Defining a Problem; An Illustration; Conclusion

Statistics in Research

Statistics in Research; Measures of Central Tendency; Measures of Dispersion; Measures of Asymmetry (Skewness); Measures of Relationship; Simple Regression Analysis; Multiple Correlation and Regression; Partial Correlation; Association in Case of Attributes. 16 **hours**

Unit III: Interpretation and Report Writing

Meaning of Interpretation; Why Interpretation? Technique of Interpretation;Precaution in Interpretation; Significance of Report Writing; Different Steps in Writing Report; Layout of the Research Report; Types of Reports; Oral Presentation; Mechanics of Writing a Research Report; Precautions for Writing Research Reports; Plagiarism, tools for checking plagiarism; Conclusions.

The Computer: Its Role in Research

Introduction; The Computer and Computer Technology; The Computer System;Important Characteristics; The Binary Number System; Computer Applications; Computers and Researcher.

16 hours

References:

Text Book

1. Research methodology - methods and techniques by C R Kothari and Gaurav Garg, New Age International (P) Ltd, 2019.
2. Statistics by Murray R Spiegel, Larry J Stephens, Schaum's outiline series, 6 Edition, 2017.

Paper II Ph.D. Phy 102
Elements of Research Techniques in Physics
(Teaching Hours: 3 Hours per week, Max Marks: 100, Credits: 04)

Unit I: Research Techniques in Astrophysics and Atmospheric Physics

Apparent and apparent magnitudes-relation between them, Equatorial coordinate system, Systems of time measurements-LST, IST, UT, Julian Date-Modified JD, Constellations, Catalogs, Surveys, Atmospheric window, Atmospheric extinction, Galactic reddening correction, NHI values, colors, Doppler shift correction, Photometry and spectroscopy, Imaging studies, IRAF software tools

8 hours

Electromagnetic energy, Laws regarding the amount of energy radiated from an object, Planck Radiation Law, Wien's displacement law, Rayleigh Jeans law, Black body concept, emissivity and Radiant Temperature, Electromagnetic Spectrum, Wavelength bands, Earth and its atmospheric layers, Atmosphere effects - Scattering, Absorption, Reflectance spectra, Grain Size Effects.

8 hours

Unit II: Experimental techniques in Condensed matter Physics and Spectroscopy

Preparation of Materials: Crystal Growth, Amorphous materials, Nano materials, Polymers by different techniques, Sol-gel, Hydrothermal, Combustion techniques. Study of Crystal Structure: X-ray diffraction (XRD), UV-Vis, PL, Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), HRTEM, EDAX, XPS, Complex impedance spectroscopy. **8 hours**

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Fundamentals of IR and Raman Spectroscopy- Fundamentals, Experimental techniques. IR spectrum - group frequencies and finger print region Applications of IR and Raman spectral studies: Identification of molecular fragments and constituent functional groups. Material characterization
Luminescence, Fluorescence and Phosphorescence - Fundamentals, techniques and applications
Spin Resonance spectroscopic methods (NMR and ESR)- Fundamentals and experimental technique. Spectral parameters – Applications in the study of structure and dynamics of condensed systems. Zero field NMR- fundamentals and applications

8 hours

Unit III: Research techniques in Nuclear Physics

Interaction of nuclear radiations with matter: Heavy charged particles, fast electrons, gamma rays and neutrons.
General properties of radiation detectors: Pulse height spectra, counting curves and plateaus, detection efficiency, energy resolution and dead time.
Types of detectors: Gas filled detectors - Ionisation, proportional and GM counters; Scintillation spectrometers – Liquid scintillation and NaI(Tl) scintillation spectrometers; Semiconductor spectrometers – Surface barrier, Lithium ion drifted and High Purity Germanium spectrometer ; Neutron detector – BF_3 counter.

8 hours

Nuclear electronics and pulse processing
Op amp applications: Sample and hold circuit; Schmitt trigger; Peak detector; Active filters – Low-pass, high-pass, band pass, notch, band-Reject and state–variable biquad filters; Oscillators - Wien bridge, phase-shift, relaxation, triangle, square wave oscillators; Preamplifiers - Voltage and charge sensitive, Pile-up effect; Pulse processing and shaping; Linear pulse amplifier; Delay line, Single-

channel analyser, Analog-digital convertor, Time-amplitude convertor, Coincidence and anticoincidence; Multichannel analyser, Multiscaler and Digital processing.

8 hours

References:

1. Introduction to Modern Astrophysics, Bradley W Carroll and DA Ostlie, Pearson- Addison Wesley, 2007.
2. The Physical Universe, Frank Shu, University Science Book, 1981.
3. Fundamental Astronomy, Karttunen H, Kroger P, Oja H, Poutanen M (Eds), Springer, 1997.
4. Principles of Remote sensing, Klaus Tempfli, Norman Kerle, Gerrit C Huurneman, Lucas L F Janseen, ITC Publications, Netherlands, 2001.
5. Nanostructured Materials-Processing, Properties and Applications, Carl C Koch, William Andrew Publishing, Norwich, New York, USA, 2004.
6. Nano Materials: Synthesis, Properties and Applications, Edited by A S Edelsteins, R C Cammarata, Institute of Physics Publishing, Bristol and Philadelphia, 1996
7. Nano particles and nano structured films: Preparation, characterization and applications, Ed. J H Fendler, John Wiley and Sons, 1998.
8. Fundamentals of Molecular Spectroscopy, Banwell and McCash, Tata McGraw Hill, 1998.
9. Modern Spectroscopy, JM Hollas, John Wiley, 1998.
10. Molecular Quantum Mechanics, PW Atkins and RS Friedman, 3rd Edition, Oxford Press, 2004.
11. Molecular Structure and Spectroscopy, G Aruldhas, Prentice Hall of India, New Delhi, 2001.
12. Radiation Detection and Measurements, GF Knoll, 3rd edition, John Wiley and Sons, 2000
13. Nuclear Radiation Detectors, SS Kapoor and VS Ramamurthy, Wiley-Eastern, New Delhi, 1986.
14. Op-Amps and Linear Integrated Circuits, RA Gayakwad, 4 Edition, Eastern Economy Edition, 2004.
15. Operational Amplifiers with Linear Integrated Circuits, William Stanley, 4Edition, CBS Publishers, 2002.
16. Analog signal processing, Ramon Pallas-Areny, John G Webster, Wiley Pubs, 1999.

Paper III: Ph.D. Phy 103.1

Stellar Astrophysics and Observational Techniques

Unit-1: Basic Astronomical and Astrophysical concepts

Positions on the celestial sphere, Kepler's laws, Virial theorem, Black body radiation, Flux density and luminosity, basics of Radiative transfer and Radiative processes, Magnitudes, Motions and Distances of Stars : Absolute stellar magnitude and distance modulus, Bolometric and radiometric magnitudes, Colour-index and luminosities of stars, Stellar positions and motions, Velocity dispersion, Statistical and moving cluster parallax, Extinction, interstellar reddening law, Stellar temperature, Effective temperature, Brightness temperature, Color temperature, Kinetic temperature, Excitation temperature, Ionization temperature, Spectral Classification of stars, Utility of stellar spectrum, stellar atmospheres.

(16 hours)

Unit-2: Overview of the major contents of the universe and Star Clusters

Sun and stars, stellar interiors, low and high mass stars evolution, HR diagram, Hertz sprung gap, Stellar Structure, stellar opacities, stellar polytropes, Energy Generation in Stars: Calculation of thermonuclear reaction rates for non-resonant and beta-decay reactions, The various reaction chains: pp-I, II, III, CNO, He-burning, C-burning, Si-burning, photo-dissociation neutrino astronomy, binary stars, variable stars, white dwarfs and neutron stars, black holes, composition, properties and amount of interstellarmatter,21-cmlineobservationsofinterstellarmatter, shape, size and contents of our galaxy, basics of stellar dynamics, normal and active galaxies, dark matter and dark energy.

Population I, II and III stars, Globular and open star clusters, Stellar associations, classification of open clusters, interstellar reddening, determination of radius, spatial structure and cluster membership, colour – colour and colour magnitude diagrams, isochrones and cluster ages, dynamical evolution and mass segregation, Luminosity and Mass function, star clusters as galactic mappers. (16 hours)

Unit-3: Telescopes, Detectors and data reduction techniques

Types of telescopes, Spherical and Chromatic aberrations, resolution and sensitivity, Telescopes at different wavelengths, imaging, Johnson and Cousins system, spectroscopy, Spectro-polarimetry. Theory of atmospheric turbulence and extinction, Basic formulations ofatmospheric turbulence, Detectors, Photo-electric effect, Detecting light, Photo-detector elements, Detection of photo-electrons, Image intensifiers, Single photon counter, sensitivity, noise, quantum efficiency, spectral response, Johnson noise, signal to noise ratio, background, aberrations, detectors at different wavelengths, calibration, CCD, Correlation measurements.

IR/Optical/UV: CCD fundamentals, imaging systems, point-spread-function, photometry and spectroscopy, Image Reduction and Analysis Facility, CCD data reduction procedures, Dominion Astrophysical Observatory Photometry, Aperture Photometry, errors and propagation of errors.

(16 hours)

Recommended books

- Roy,A.E.,&Clarke,D.:Astronomy Principles and Practice.
- Allen,C.W.: Astrophysical quantities
- Bohm-vitense, E.: Introduction to Stellar Astrophysics (Vols. I,IIandIII)
- Astronomical Optics: D.J.Shroeder
- Spherical Astronomy: W.M.Smart
- AnIntroduction to Modern Astrophysics: B.W.Carrol&D.A.Ostlie
- A User's Guide to Stellar CCD Photometry with IRAF: Philip Massey and L.E.Davis
- A Reference Guide to the IRAF/DAOPHOT Package
- Instrumentation for Ground-based Optical Astronomy: L.B. Robinson

Paper III : Ph.D Phy 103.2

OXIDE NANOMATERIALS

Unit -I

Oxide Materials : Introduction to Metal oxides, Transition metal oxides, some important transition metal oxides (ZnO, TiO_2, SnO_2, etc..), nanomaterials, theory of size, confinement and oxidation effects on nanomaterials, metal oxide nanomaterials,Magnetic,electrical and optical properties of Transition metal oxides 16 hours

Unit- II

Synthesis of metal oxide nanoparticles : classification of various synthesis techniques, top-down processes (ball milling, lithography, e-beam/ion beam processing), bottom-up processes (co-precipitation methods , sol-gel proscessing, solution combustion method), thin film deposition techniques (DC-sputtering, RF-sputtering, pulsed laser deposition, molecular beam epitaxy,Chemical vapour deposition) 16 hours

Unit- III

Characterization, Properties and applications of oxide nanomaterials : Structural characterization and Particle size calculation through XRD, microstructural properties through SEM and TEM, optical characterization (photoluminescence,UV- Visible and IR spectroscopy, Raman spectroscopy,Absorption spectroscopy, Mossbauer spectroscopy, Impedence spectroscopy, Magnetic measurements),Applications in Photovoltaics, memory and electro-optic devices 16 hours

References:

1. Introduction to nanotechnology, *C. P. Poole and F. J. Owens*
2. Synthesis, properties and applications of oxide nanomaterials, edited by *J. A. Rodriguez and M. F. Garcia*, JohnWiley & Sons, Inc., Hoboken, New Jersey
3. Nanoscale Science and Technology, Edited by *Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan*, John Wiley & Sons
4. Nanostructures and nanomaterials : Synthesis, Properties and Applications, *Guozhong Cao*, Imperial College Press

5. Chemistry of Nanocrystalline Oxide Materials: Combustion Synthesis, Properties and Applications, *K.C. Patil, M. S. Hegde, Tanu R, S. T. Aruna*, World Scientific press.
6. 1. Nanotechnology, Foster, Pearson Education Inc., New Delhi, 2006.
7. Introduction to Nanoscience, *Harnyak, Dutta, Tibbals and Rao*, CRC press, New York, 2008.
8. Hand book of Nanoscience, Engineering and Technology, *William.A Goddard-III et al* CRC Press, 2003.
9. Introduction to Nanotechnology, *Charles P. Poole Jr. and Frank J. Ovens*, Wiley Interscience, 2003.

Paper IV: Ph.D. Phy 104 Research and Publication Ethics (RPE) (Teaching Hours: 2 Hours per week, Max Marks: 50, Credits: 02)

Unit I: RPE 01: PHILOSOPHY AND ETHICS 1. Introduction to philosophy: definition, nature and scope, concept, branches. 2. Ethics: definition, moral philosophy, nature of moral judgements and reactions.

(3 hours)

Unit II: RPE 02: SCIENTIFIC CONDUCT 1. Ethics with respect to science and research. 2. Intellectual honesty and research integrity. 3. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP). 4. Redundant publications: duplicate and overlapping publications, salami slicing. Selective reporting and misrepresentation of data. (5 hours)

Unit III: RPE 03: PUBLICATION ETHICS 1. Publication ethics: definition, introduction and importance. 2. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. 3. Conflicts of interest. 4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types. 5. Violation of publication ethics, authorship and contributorship. 6. Identification of publication misconduct, complaints and appeals. 7. Predatory publishers and journals. (7 hours)

PRACTICE RPE 04: OPEN ACCESS PUBLISHING 1. Open access publications and initiatives. 2. SHERPN/RoMEO online resource to check publisher copyright & self-archiving policies. 3. Software tool to identify predatory publications developed by SPPU. 4. Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc. (4 hours)

RPE 05: PUBLICATION MISCONDUCT (4 hrs.) A. Group Discussions 1. Subject specific ethical issues, FFP, authorship. 2. Conflicts of interest. 3. Complaints and appeals: examples and fraud from India and abroad. (2 hours) B. Software tools Use of plagiarism software like Turnitin, Urkund and other open source software tools. (2 hours)

RPE 06: DATABASES AND RESEARCH METRICS (7 hrs.) A. Databases 1. Indexing databases. 2. Citation databases: Web of Science, Scopus, etc. (4 hours) B. Research Metrics 1. Impact Factor of

journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score. 2. Metrics: h-index, g index, i10 index, altmetrics. (3 hours)

References:

1) Bird, A. (206). Philosophy of Science. Routledge.

2) MacIntyre, Alasdair (1967) A Short History of Ethics. London.

3) P. Chaddah, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized,

ISBN:978-9387480865

4) National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition. National Academies Press.

5) Resnik, D. B. (2011). What is ethics in research & why is it important. National Institute of Environmental Health Sciences, 1-10. Retrieved form http://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm

6) Beall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179-179. https://doi.org/10.1038/489179a

7) Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019), ISBN: 978-81-939482-1-7. http://www.insaindia.res.in/pdf/Ethics_Book.pdf