FACULTY OF SCIENCES

SYLLABUS

FOR

PRE-PH.D COURSE IN PHYSICS
(CREDIT BASED EVALUATION & GRADING SYSTEM)

(Semester I-II)

Session : 2019-20

GURU NANAK DEV UNIVERSITY
AMRITSAR

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PRE-PH.D COURSE IN PHYSICS (SEMESTER SYSTEM)
(CREDIT BASED EVALUATION & GRADING SYSTEM)

SCHEME

Note : All Theory Papers having Mid Semester Marks : 20 & End Semester Marks : 80. Total Marks will be 100.

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Course from the outside the Department (O-1): Mathematics, Chemistry, Computer Science, Electronics Technology and Computer Engineering & Technology

Elective Courses from the Department (E-1) Select any one from the following courses

- PHL-981 Etched Track Detector & their Applications
- PHL-982 Novel Materials
- PHL-984 High energy Physics
- PHL-985 Ion Beam Interaction
- PHL-986 Chemical Sensors
- PHL-987 Vacuum Science & Thin Films
- PHL-988 Material Characterization techniques
- PHL-989 Physics of Amorphous Materials
- PHL-990 Plasma Theory
- PHL-991 Advanced Digital Signal Processing and Applications
- PHL-992 Radiation Protection and Dosimetry
- PHL-993 Quantum Computation
- PHL-994 Organic Electronics
RESEARCH METHODOLOGY

Course No. PHL-901

L T P 4-0-0

Time: 3 Hours

Mid Semester Marks : 20
End Semester Marks : 80

Max. Marks: 100

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section - A
Research Aptitude: Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is done.

Research Process: Reviewing the literature, Formulation of research problem, Nature and type of variables, Hypothesis - meaning, types, development of hypothesis and its testing, Meaning & Functions of Research Design

Section – B
Data Analysis: Sources, acquisition and interpretation of data, Quantitative and qualitative data, Graphical representation and mapping of data, Sensitivity Analysis with Data Tables, Optimization with EXCEL Solver, Summarizing Data with Histograms and Descriptive Statistics, Pivot Tables, Summarizing Data with database statistical functions, using correlation, Multiple Regression, Using Sampling to Analyze Data

Section-C
Significance of Report Writing: Different Steps in writing Report, Layout of the Research Report, Types of Reports, Mechanics of Writing a Research Report, Art of scientific writing- Steps to better writing, flow method, organization of material and style, Drawing figures, graphs, tables, footnotes, references etc. in a research paper

Section D
Use of internet in research work : Use of internet networks in research activities in searching material, paper downloading, submission of papers, relevant websites for journals and related research work. Introduction to Patent laws etc., process of patenting a research finding, Copy right, Cyber laws.
References:

1. Research Methodology Methods and Techniques, Kothari, C. R., Wiley Eastern Ltd.


4. Practical Research Methods, Dawson, C., UBSPD Pvt. Ltd.

5. Research Methodology, Sharma, N. K., KSK Publishers, New Delhi
EXPERIMENTAL TECHNIQUES

Course No. PHL-902
LTP 3-0-0

Time: 3 Hours
Max. Marks: 100
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Physical basis, theory, instrumentation and applications of X-Ray Fluorescence Spectroscopy; LASER fluorimetry; Gamma-Gamma method; Neutron activation analysis and Neutron-Neutron method.

Section B
Gamma ray spectrometric technique for uranium, thorium and potassium analysis. Alpha particle track etch detector.

Section-C

Section-D

References:
THEORETICAL TECHNIQUES

Course No. PHL-903

Time: 3 Hours

Max. Marks: 100
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the
four Sections (A-D). Questions may be subdivided into parts (not exceeding four).
Candidates are required to attempt five questions, selecting at least one question from each
Section. The fifth question may be attempted from any Section.

Section-A
Dynamical systems, Linear and non-linear forces, Mathematical implications of
nonlinearity, Effects of nonlinearity, linear oscillators and periodicity,

Section-B
Damped and driven nonlinear oscillators, Primary resonance and jump phenomena,
Subharmonic and super-harmonic resonances, Nonlinear oscillations and bifurcations.

Section-C
Autonomous and non-autonomous systems, Dynamical systems as coupled first-order
differential equations, equilibrium points, Phase plane, Phase space and phase trajectories,
Stability, Attractors and repellers,

Section-D
Classification of equilibrium point, examples, Limit cycle motion, Higher dimensional
system, Lorentz equations, Quasi-periodic attractors, Poincare map, Chaotic attractor, Some
simple bifurcations, Discrete dynamical systems, Cobweb diagrams, Bifurcation scenario in
Duffing oscillator.

References:

1. Non-linear Dynamics – Springer M. Lakshman and S. Rajasekar
PRE-PH.D COURSE IN PHYSICS (SEMESTER SYSTEM)
(CREDIT BASED EVALUATION & GRADING SYSTEM)

Etched Track Detectors & Their Applications

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Time: 3 Hours

Max. Marks: 100
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Introduction to Nuclear Track Detectors (SSNTDs), How tracks are formed : track models, Procedures for revelation of tracks,

Section-B
Relative thresholds for detection, Nature of charged detector and track, Formation Mechanisms, Track geometry, efficiency, Etching Techniques.

Section-C
Utilization in Nuclear Physics, Chemistry, Dosimetry, Alpha-particle detection, Other applications. Radon – A hazard, Nuclear track from Radon,

Section-D
Measuring Radon doses, Radon indoors, Earthquakes, Gas flow in Earth, Uranium Exploration.

Reference :
NOVEL MATERIALS

Course No. PHL-982
LTP 3-0-0

Time: 3 Hours
Max. Marks: 100
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Nucleation and growth mechanism, heat treatment techniques, Sol-gel method, thin film deposition techniques, epitaxy,

Section-B
chemical vapor deposition, sputtering, structural studies, electrical studies, spectroscopic studies, magnetic studies.

Section-C
Semiconductors, direct/indirect band gap, Materials for optoelectronics and spintronics, Dilute magnetic semiconductors and multiferroic systems,

Section-D
GaN, ZnO, TiO2 based DMS materials, Colossal magnetoresistant materials,

Reference books

1. Thin film Deposition –Donald Smith
2. Sol-Gel Science-Brinker & Scherer
3. Crystal Growth – Pamplin
4. Nanoelectronics and Information Technology- Was
HIGH ENERGY PHYSICS

Course No.                  LTP
PHL-984                      3-0-0

Time: 3 Hours
Max. Marks: 100
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Section-B
Weak Interactions, Spontaneous Symmetry breaking, Standard model, Beyond standard model, Grand Unified Theories, Supersymmetric Extensions, Different Neutrino Flavours

Section-C
Interaction of Particles with Matter: Ionization, Proportional & GM counters, Spark chambers, Bubble and Cloud chambers, Si and Ge based Semiconductor counters, Scintillation counter, Cherenkov counter, Basic components of Detector:

Section-D
Tracker, Electromagnetic and Hadronic Calorimeters, Magnet Systems, Muon counters, Accelerators: Basic Components of Accelerators, Beam Diagnostics, Cyclotron, Betatron, Synchrotrons, LINAC, Modern Detectors :- CMS & D0.

References:
1. Introduction to Elementary Particles by D. Griffiths
3. Techniques for Nuclear and Particle Physics Experiments – W.R. Le0
4. CMS Detector Technical Design Report
5. D0 Detector Technical Design Report
ION BEAM INTERACTION

Course No. PHL-985

Time: 3 Hours

Max. Marks: 100
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Stopping and ranges of ions, Stopping processes, Electronic stopping, Nuclear stopping, Straggling, Scaling Law’s. Projectiles and target, Methods of energy loss measurements;

Section-B
Secondary particle detection; Time of flight spectrometers; Electrostatic and magnetic spectrometers, Energy-loss straggling, Range and range straggling.

Section-C
Optical methods: Infrared spectroscopy, Optical and ultra-violet (UV) spectroscopy,

Section-D

References:

CHEMICAL SENSORS

Course No. PHL-986

Time: 3 Hours

Max. Marks: 100
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Section-B
Metal/Liquid Interface, Semiconductor/Liquid Interface, Insulator/Liquid Interface, Solid Electrolyte/Liquid Interface.

Section-C
Role of Catalysts, Membranes, Introduction to Biosensors, Chemical Sensors, Thin Film Gas sensors,

Section-D
Solid Electrolyte-Devices; Gas Sensors based on Semiconductor Powders.

References:
PRE-PH.D COURSE IN PHYSICS (SEMESTER SYSTEM)
(CREDIT BASED EVALUATION & GRADING SYSTEM)

Vacuum Science and Thin Films

Course No. LTP
PHL-987 3-0-0

Time: 3 Hours

Max. Marks: 100
Mid Semester Marks : 20
End Semester Marks : 80

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Section-B
Measurement of Pressure: Thermal conductivity Gauge, Penning gauge, Ionization Gauge, Bayard-Alpert Gauge, Residual Gas Analyzer
Production of Vacuum: Mechanical pumps (Rotary, Root and Turbomolecular pumps), Diffusion pump, Getter and Ion pumps, Cryopumps.

Section-C
Physical Vapor Deposition - Hertz Knudsen equation; mass evaporation rate; Directional distribution of evaporating species Evaporation of elements, compounds, alloys, e-beam, pulsed laser and ion beam evaporation, Glow Discharge and Plasma, Sputtering - mechanisms and yield, DC and RF sputtering, Bias sputtering, magnetically enhanced sputtering systems, reactive sputtering, Hybrid and Modified PVD-Ion plating, reactive evaporation, ion beam assisted deposition

Section-D
Chemical Vapor Deposition - reaction chemistry and thermodynamics of CVD; Thermal CVD, laser & plasma enhanced CVD, Chemical Techniques - Spray Pyrolysis, Electrodeposition, Sol-Gel and LB Techniques, Nucleation & Growth: capillarity theory, atomistic and kinetic models of nucleation, basic modes of thin film growth, stages of film growth & mechanisms, Epitaxy - homo, hetero and coherent epilayers, lattice misfit and imperfections, epitaxy of compound semiconductors,
References:


(3) Vacuum Technology, A. Roth, Pergamon Press Ltd. , Oxford


PRE-PH.D COURSE IN PHYSICS (SEMESTER SYSTEM)
(CREDIT BASED EVALUATION & GRADING SYSTEM)

Materials Characterizations Techniques

Course No. PHL-988
LTP 3-0-0
Time: 3 Hours
Max. Marks: 100
Mid Semester Marks : 20
End Semester Marks : 80
Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Magnetometry: Vibrating Sample Magnetometry, Thermomagnetic Analysis, SQUID

Section-B

Section-C

Section-D

References:
Physics of Amorphous Materials

Course No. 
PHL-989

LTP
3-0-0

Time: 3 Hours
Max. Marks: 100
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Section-B

Section-C
Entropy of Glasses. Anomalous properties of water. Polaymorphism in amorphous Solidified water (ASW), Triphenyl phospite, Y_2O_3-Al_2O_3 glasses, molten phosphorus. Negative absolute pressure and phase separation in mixtures.

Section-D
Glass preparation by quenching, roller quenching, melt spinning, ion and neutron irradiation and pressure induced amorphization (PIA). Characterization of glasses by optical, Raman and MAS-NMR spectroscopy. Radial Distribution function analysis of glasses by x-ray and neutron diffraction. SAXS and SANS investigation of glasses.
References:


4. The Glass Transition, E. J. Donth, Springer-Verlag
PLASMA THEORY

Course No. PHL-990

Time: 3 Hours
Max. Marks: 100
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Continuity, Momentum conservation, Equations of state, Magneto-hydrodynamics.
Conservation of energy and magnetic flux, Magnetic Reynolds number, Equilibrium relations, Magnetic Pressure. Unmagnetised plasmas.

Section-B
Magnetised Plasmas, Nonlinear plasma waves, basic of soliton theory, Rayleigh-Taylor instability, Modulation and filamentation instability, Flute instability, MHD instabilities, Tearing instability, Parametric instabilities.

Section-C

Section-D
Microscopic instabilities, Inverse Landau damping, ion acoustic wave instability, Absolute and convective instabilities.

References:
PRE-PH.D COURSE IN PHYSICS (SEMESTER SYSTEM)  
(CREDIT BASED EVALUATION & GRADING SYSTEM)

ADVANCED DIGITAL SIGNAL PROCESSING AND APPLICATIONS

Course No.  
PHL-991

LTP  
3-0-0

Time: 3 Hours  
Max. Marks: 100

Mid Semester Marks : 20  
End Semester Marks : 80

Mid Semester Examination: 20% weightage  
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Adaptive filtering; Minimum Mean Square Error Criterion; the Widrow LMS Algorithm; Recursive Least Square Algorithm.

Section-B
Sampling; Sampling rate Conversion; Signal flow Graphs; Filter Structures; Polyphase Decomposition; Digital filter Banks; Two-channel Quadrature Mirror-Filter Banks; Multilevel Filter Banks; Introduction to Wavelets.

Section-C
Applications to Voice Processing, Applications to RADAR,

Section-D
Applications to Wireless Communications, Applications to Image Processing.

References:

Radiation Protection and Dosimetry

Course No. PHL-992

LTP 3-0-0

Time: 3 Hours

Max. Marks: 100
Mid Semester Marks: 20
End Semester Marks: 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

Section-A
Radiation & need for its measurements, physical features of radiations, conventional sources of radiation, tissue equivalent materials, radiation dose,

Section-B
Definition of dose quantities: - Fluence, kerma, exposure, absorbed dose, Dose equivalent, Quality factor Q, effective dose equivalent, determination of dose equivalent, Radiation quality.

Section-C
Thermoluminescent dosimetry (TLD): - Theoretical aspects of thermoluminescence, Characteristics of TL dosimeters, commercial TLD dosimeters, - LiF, Li2B4O7, CaSO4, MgB4O7, TLD instrumentations, Applications of TLD.

Section-D
An introduction to Photoluminescence(PL), Solid state Nuclear Track dosimetry, Internal dosimetry, External dosimetry, Effects of radiations exposure, history of radiation protection standards, current limits of radiation exposure, protective barriers for radiation sources, protection for sealed sources, radiation surveys, personal monitoring.

References:
1. Techniques of Radiation dosimetry by K.Mahesh, D.R Vij
2. Fundamentals of Radiation dosimetry by J.R Greening
3. Thermoluminescent dosemetry by A.F Mikhlen
5. Radiation shielding and dosimetry by A.D Profio
PRE-PH.D COURSE IN PHYSICS (SEMESTER SYSTEM)  
(CREDIT BASED EVALUATION & GRADING SYSTEM)

QUANTUM COMPUTATION

Course No. LTP
PHL-993 3-0-0

Time: 3 Hours

Max. Marks: 100
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Introduction to Quantum Information, Review of quantum mechanics, Review of linear algebra and quantum mechanics, Stern-Gerlach experiment, Quantum teleportation

Section-B
Introduction to computer science, Quantum logic gates- one qubit gate and two qubit gate, Quantum circuits, Quantum algorithms, Private and public key cryptography

Section-C
Quantum fourier transform, Factoring: Shor's algorithm, Quantum parallelism, Deutch's algorithm, Quantum search algorithm (Grover’s search), Quantum error correction

Section-D
Types of quantum computational schemes: Ions, Neutral atoms, NMR, Quantum dots, Introduction to fault-tolerant quantum computing

References:
2. Handbook of Quantum Information
3. Quantum Information Science and Technology Roadmap
ORGANIC ELECTRONICS

Course No. LTP
PHL-994 3-0-0

Time: 3 Hours Max. Marks: 100

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Theory, classification and applications; Band theory of molecular crystals; Excited and ionized states of molecular crystals.

Section-B
Electronic carrier transport; Equilibrium distribution of electrons and holes; Carrier generation, Carrier transport, Carrier recombination; Basic conduction process: Space charge limited conductivity, Poole-Frenkel effect.

Section-C
Variable range hopping conduction, Tunnelling, Schottky effect, Diode type conductivity; DC and AC electrical properties.

Section-D
Single layer diodes, Heterojunction diodes, Organic solar cells, Dye-sensitized solar cell and organic light emitting devices.

References: