UNIVERSITY OF CHITTAGONG

DEPARTMENT OF PHYSICS

SYLLABUS FOR MASTER OF PHILOSOPHY **(M. PHIL.)** COURSES IN PHYSICS

SESSION: 2011- 2012 & 2012-2013

The Master of Philosophy (**M.Phil.**) course in physics shall consist of two theory papers, one viva-voce paper and submission of one dissertation. The theoretical papers are each of 100 marks and of four hours duration and the viva- voce examination will carry 100 marks. The theory and viva – voce examinations shall be held normally at the end of the first academic year of admission. The dissertation shall be submitted normally at the end of the second academic year.

An M. Phil. Student must choose any Two Papers mentioned below for his/her theoretical examination in consultation with the Chairman of the Department and his/her proposed supervisor.

Each paper will carry 100 marks and the examination will be of 4 hours duration.

Marks Distribution

Theoretical Papers $2\times100 = 200$
Viva –voce $= 100$

Theoretical Papers

PHYS – 601: Group theory and Advanced Quantum Mechanics.
PHYS – 602: Theoretical Physics
PHYS - 603: Solid State Physics
PHYS – 604: Atmospheric Physics
PHYS – 605: Climatology
PHYS – 606: Quantum Field Theory of Solid
PHYS –607: Nuclear Physics
PHYS –608: Semiconductor Devices and Applied Electronics
PHYS –609: Nuclear Instrumentations
PHYS –610: Radiation and Health Physics
PHYS –611: Medical Physics
PHYS –612: Biology and Physics of Human Body
PHYS –613: Gravitational Physics
PHYS—614: Semiconductor Physics and Superconductivity

PHYS – 615: Viva-voce

PHYS- 601 : GROUP THEORY AND ADVANCED QUANTUMMECHANICS

(3+2) Questions **Marks – 100** **4 hours**

GROUP –A : Group Theory

1. **Elements of group theory**: The multiplication table; Permutation groups; Vector spaces and Hilbert spaces; isomorphism and homomorphism; Coordinate geometry and vector Algebra; Function spaces &operators; The Direct sum and the Direct product of Matrices, Examples.
2. **Representation Theory of Finite groups**: - Invariant subspaces and Reducible Representations ; the Schurs`s Lemmas and Orthogonality theorem; Theorem; The Regular representation; Symmetrized Basis Functions for Irreducible Representations.
3. **Continuous groups and their representations**: Topological Groups and Lie Groups. The Rotation Group SO (2) & SO (3) . The special unitary groups SU(2) & SU (3).
4. **Group Theory in Quantum mechanics**: Hilbert spaces in Quantum Mechanics; The Transformations of a Function ; space and Time displacements; Time Reversal and space inversion symmetries; Rotation- Group; The symmetry group ; The Addition of Angular Momenta ;Irreducible Tensor operators ; Vector operators &The Wigner- Eckart Theorem.

GROUP- B: Advanced Quantum Mechanics

1. **Radiation Theory**: Classical radiation field; creation annihilation and number operators; quantization of radiation field; emission and absorption of photons by atoms.

2. **Relativistic Quantum Mechanics for spin-half particle**: Probability conservation in relativistic quantum mechanics; Dirac equation, quantization of Dirac field.

3. **Covariant Perturbation Theory**: S-matrix expansion in the interaction representation; Mott scattering; Compton scattering; Feynman electron propagator; Moller scattering.

Books recommended:

1. L.I.Schiff Quantum Mechanics(3rd Edn)
2. A.W.Joshi Elements of Group Theory for Physicists.
3. A.R.Edmonds Angular Momentum in Quantum Mechanics.
4. H. Moirhead The Physics of Elementary Particles.
5. S. Flugge Practical Quantum Mechanics.
6. R.P. Feynman and A.R. Hibbs Quantum Mechanics and path integrals.
7. J. J. Sakurai Advanced Quantum Mechanics
8. M. E. Rose Elementary Theory of Angular Momentum, John Wiley & Sons, N.Y. (1961).

PHYS – 602: THEORETICAL PHYSICS

5-Questions **Marks – 100** **4 hours**

1. **Classical Field Theory**: Development of a classical field equations, The principle of least action and the Lagrangian equations of motion; Generalized momenta and Hamilton`s equations of motion ; The equation of motion for a classical relativistic field ; invariance principle and conservation law – Noether`s theorm ; Application of Noether`s theorem.
2. **Quantum field Theory** : The klein Gordon (Scalar) Field : The single component Hermitian field; Quantization of the scalar field; The non – hermitian scalar field; the Physical interpretation of the non- hermitian scalar field;
3. **The Electromagnetic (Vector) Field**: The classical electromagnetic field; The calculation of electromagnetic field and potentials , Quantization of the electromagnetic field.
4. **The Dirac (Spinor) Field**: The planc wave representation: The Hamiltonian operator for the Dirac field ; The Quantization of the Dirac field ; charge and current operators for the Dirac field .
5. **Relativistic Kinematics**: Lorentz transformation and invariants; Lorentz transformation to the rest system of an arbitrary particle ; transformation of differential cross- sections. Jacobian determinant phase space consideration ; Precession of the polarization of spin.
6. **Dispersion Relations** : The Kramers Kronig relation; Mandelstam Representation for non relativistic potential scattering , Mandelstam representation for relativistic scattering ; Raggee poles in non – relativistic and relativistic scattering .
7. **Fundamental processes of Feynman rules**: Feyman diagrams for scattering processes; calculation of Feynman diagrams.
8. **Strong, week and Electromagnetic Interactions**; Invariance and conservation laws; Symmetries of strong interaction; Poin – nucleon scattering ; Compton scattering ; beta decay.

Books recommended:

1. Keith A. Buckner- Advances in theoretical Physics.
2. Goldstein – Classical Mechanics.
3. Landau & Lifshitz – Quantum Electrodynamics. / Classical theory of fields.
4. J.J. Sakurai – Advanced Quantum Mechanics.
5. Sexana, Gupta & sexana – Fundamentals of solid state physics.
6. A.M. Harun ar- Rashid – Glashow Salam Weinberg Theory .

PHYS – 603: SOLID STAE PHYSICS

5 Questions **Marks – 100** **4 hours**

1. Introduction: Over view of Crystal structure and Bonding in solids, Lattice dynamics of one, two, and three dimensional lattices, Elastic constants, Dielectric constant and related parameters, Basics of Antiferromagnetism and Ferrimagnetism, Green's Function Technique-application to Solid State Physics.

2. Band energy and structure Calculation of Solid:

Introductory remarks on Energy bands in solids, Different methods of band energy calculation; Tight binding method (a review), Effective Hamiltonian method, Pseudo potential method; BS (Betternet and Silvert) method.

3. Ferroelectric Crystals:

Classification of Ferroelectric Crystals: Ferroelectricity in ionic Crystals; The Polarization Catastrophy: Nature of the Phase Transition, Second Order Transition, First Order Transition; Low Frequency Optical Phonon: Experiments with Strontium Titanate, Piezoelectricity, Ferroelectric Domain.

4. Phonons in Metals:

Elementary Theory of Phonon Dispersion Relation, Velocity of Sound, Khon Anomalies, Dielectric Constant of a Metal, Effective electron-electron Interaction, Phonon contribution to the One electron Energy, Electron-Phonon Interaction, Temperature Dependent Electrical Resistivity of Metals, Effect of Umklapp process, Phonon Drag.

5. **Physics of Semiconductors**: Intrinsic and extrinsic semiconductors and their important properties, Study of electrical conductivity, Mobility of currents carriers, Hall effect in Semiconductors, Fractional Quantum Hall effect, Band gap calculation of Different Semiconducting materials, Semiconductor devices and their technology.

6. Superconductivity:

Phenomenological G-L Theory; Basic Foundation, G-L Equations and their Solutions, Microscopic BCS Theory; Cooper pairs, Transition temperature, Energy gap, High-T_c Superconductivity; Structural Aspects and Significant Properties, Vortex Structure, Flux Creep and Flux Flow Model; Magnetic Relaxation in HTSC, Concept of superconductor Devices, High power application of Superconductivity; Energy Storage devices; SMES, TES, High magnetic field application; Maglev, SQUID-technology and its large scale application in modern science.

7. Magnetic Resonance imaging: Concept of Nuclear Magnetic Resonance; Equations of Motion, Nuclear Quadrupole Resonance, Antiferromagnetic Resonance, Electron Paramagnetic Resonance, Spin Wave Resonance. The basic theory of Magnetic Resonance Imaging (MRI), Medical Applications; MRI scans Techniques, MRI versus CT, the recent Development of MRI.

Books recommended:

1. C. Kittle -- Solis State Physics
2. A. J. Dekker – Solid State Physics
3. B.S. Saxena, R.C. Gupta and P.N. Saxena – Fundamentals of Solid State Physics
4. N.W. Ashcroft and N.D. Mermin – Solid State Physics
5. N.F. Mott and E.A. Davis – Electronics Process in Non-Crystalline Materials
6. A.O.E. Animalu – Intermidiate Quantum Theory of Crystalline Solids
7. W.A. Harrison – Solid State Physics
8. P.W. Anderson – The Theory of Superconductivity in the High-Tc Cuprates
9. J. P. Mckelvey – Solid State and Semiconductor Physics.
10. M.A. Omar – Elementary Solid State Physics
11. R.A. Levy – Principles of solid State Physics
12. M Sachs – Solid State Theory
13. S.O. Palli – Solid State Physics
14. J.P. Srivastava – Elements of solid state Physics.
15. H.E. Hall –Solid State Physics.
16. J.S. Blakemore- Solid State Physics.
17. I.S. Sokolnikoff – Mathematical Theory of Elasticity.
18. Chikasumi- Physics of Magnetism .
19. Landau and Lifshitx – Theory of Elastcity .
20. J.M. Ziman Electrons and Phonons .
21. M.P. Marder- Cibdebsed Natter Physics
22. O. Madel – Introduction to solid state Theory .
23. T.R. Louck – Augmented plane Wave Method .
24. H. L. Skriver- The LMTO method.
25. O. Madelung- Introduction to Solid State Theory.
26. M.R. Islam - Superconductivity- an introduction (unpublished).

PHYS -604:ATMOSPHERIC PHYSICS

5 Questions **Marks – 100** **4 hours**

1. **Aeronomy and aerology:** Origin and composition of the atmospheric distribution of atmospheric mass and gaseous constituents; charged particles in the atmosphere, vertical distribution of temperature and methods of its measurements an lonosphere: Thermosphere, Rawinsonde and pilot balloon observation.

2. **Physical meteorology :** Application of basic thermodynamic laws in atmosphere; Dry Adiabatic Lapse Rate, saturated lapse rate and Normal lapse rate; thermodynamic stability and instability. Geopotential height , pressure tendency equation . Thermodynamic diagrams and applications.
3. **Dynamic Meteorology:** The momentum equation , circulation and vorticity, the plenctary boundary layer; linear perturhation theory; general circulation , Eckman spiral; gravity and lee waves, Cyclogenesis and frontogenesis.
4. **The radiation of the atmosphere:** The atmospheric absorption and emission of infrared radiation; Scattering of solar radiation, radiation heat transfer, measurement of solar radiation , radiation heat transfer , measurement of solar radiation and terrestrial radiation parameters; radiation parameters ; radiation balance in the earth atmop here system.
5. **Cloud physics:** Cloud morphology, formation of clouds and precipitation, Formation of hails and thunder storm, artifical modification of clouds, cloud modeling.
6. **Synoptic meteorology :** Structure of the meteorological services; organization of weather forecasting ; Weather analysis, techniques, Depression and fronts and their analysis and forecasting, jet stream and wind analysis, forecasting of surface temperature, wind precipitation , fog and thunder storms, synoptic processes.

7. **Tropical meteorology:** Cumulus convection , equatorial disturbances; ITCZ tropical cyclones, the monsoons and related synoptic process; CISK theory of tropical disturbances , barotropic and baroclinc instabilities theory of tropical disturbances, barotropic and baroclinic instabilities theory of storm surges.

8. **Satellite meteorology:** Satellite orbits, visible and infrared infrared imagery, Naph analysis , surface temperature measurements, use of satellite information in weather foreasting,sensors and their characteristics in weather satellites, forecasting of the tropical cyclones.
9. **Numorical prediction of weather:** Classification of atmospheric motion Basic hydrodynamic equations; Hydrodynamic equation for turbulent atmosphere ; layer and its characteristics; simplication of equations; Hydrodynamic equations of large scaleatmospheric motion in the coordinate systems related to pressure ; theory of change of pressure in barotropic atmosphere in quasig eostropicaprocimation ; quasigeostropic prognostic models ; Theory of change of meteorological elements in baroclicic atmosphere in quasigeostropicappoximation; quesiselenoical pregnestic models, Arakaa – shubert model.

Books recommended :

1. Cols : Introduction to meteorology.
2. Haltmer and Martin : Dynamical and Physicsl meterology .
3. A.G.Tarakenov : Tropical meteorology.
4. Dietrich : General Oceanography.
5. Hidy : The winds; Theorigin and behaviour of atmospheric motion .

6. Greey : The atmosphere.
7. Fleagle and Businger : Introduction to atmospheric Physics.
8. Hess , S.L. : Introduction to Theoretical Meteorology.
9. Holton J.R. :Introduction to dynamical meteorology.
10. Houghton J. T. : The physics of atmospheres.
11. Rogers RR : A short course in cloud physics .
12. Wallace and Hobbs : Atmospheric science.
13. Petterson : Weather analysis and forecasting .
14.Wickham : Practic if weather forecasting .
15. Kondrave : The radiation of the atmosphere .
16. Kondratev : Satellite meteorology .
17. Raiht : Tropical meteorology .
18. Ramage : Monsoon meteorology.
19. Byers : General meterology.
20. Belov : Methods of nonmusical weather forecasting

PHYS -605: CLIMATOLOGY

5 Questions **Marks – 100** **4 hours**

1. **Weather, climate and Climatology:** Weather and climate, characteristics, Factors of climate formation , methods of climate classification climatic zonos of the earth .
2. **Methods of climatologically data processing:** General methods of climatologically data processing; sources of climatological data, conception about meteorological services; basic climatological parameters and their processing ,(Temperature, humidity,

rainfall, atmospheric pressure , wing , cloud). Time series analysis, harmonic analysis and spectrum analysis.

3. **Agroclimatology:** Principal climatological factors , necessary for plant life ; classification of lants, principles of agricultural evaluation of climate; evaluation of thermal evaluation of climate; evaluation of thermal and light resources; evaluation of moisture; dangerous wather phenomena and agricultural products; Agroclimatological zones; crop selection and climatological parameters ; Agricultural indices from satellite observations (Vegetation index)
4. **Climate change:** Methods of climate changing pattern, climate ages, climate modeling .
5. **Micro –climatology:** Methods of microclimatic observations, Heat transfer of the surface of the bedding surface, Distribution of temperature at different depths.

Books recommended :

1. Austin and Haurtwioz : Climatology.
2. Marchik : Methods of humetical forcasting.
3. Kendrew : Climate of the continents .
4. Thnnchill : Drought, its couse and effect.
5. Sulton : Micrometeorology.
6. Treworwarthe : Introduction to climate.
7. Oritchfield : General Climatology.
8. Miller : Climatology.
9. Lamb : Changing climate, Selected papers.
10. UNESCO : Agroclimatological methods . (proceedings)
11. UNESCO : Climatology and micro- Climatology (Proceedings)
12. UNESCO :Climatology; reviews of research (Proceedings)
13. UNESCO : Problems of the arid zones (Proceedings)
14. Barry, Charley : Atmosphere , weather and climate.
15. Keepo Dehong : Weather and climate.
16. Sellers : Physical dimatology.
17. Runneey, George : Climatology and world climates.
18. Lockwood : Causes of climates.
19. Barrott : Viewing weather from paace.
20. Reiter :Jet stream meteorology.
21. Lusigues, Brace : etal Global
22. Change,Jen : Atmospheric circulation system and climates.
23. Palmcn and Ncwton : Gencral circulation of the atmosphcrc.

PHYS-606: QUANTUM FIELD THEORY OF SOLIDS

5 Questions **Marks – 100** **4 hours**

1. **Harmonic Oscillator Model**: The quantum mechanical Oscillator: Creation and Annihilation Operators, The calculation of expectation values, The use of Bose operators, The Displaced Harmonic Oscillator: A model for elementary excitations in Solids.

2. **Field Quantization**: The linear atomic chain: Classical treatment, Quantum-theoretical treatment; Phonons, Quantization of the scalar wave equation, Quantization of the electromagnetic field; Photons.

3. **Second Quantization**: Quantization of the Schrödinger wave field of Bose statistics; Bosons, Quantization of the Schrödinger wave field of Fermi-Dirac Statistics; Fermions, The use of Fermi Operators.

4. **Electrons in a crystal lattice**: Bloch's theory, 'Effective mass' method, Wannier functions; wave packets from Bloch functions, Formulation of many-body problem; Hartree-Fock approximation.

5. **Interaction of electrons with Phonon**: Fröhlich's Hamiltonian operator method, Representation in the form of Feynman graps, Electrical resistance, self-energy and mass renormalization-the Fröhlich polaron, Green's Function technique; Examples of equations for Green's function and their solution.

6. **Quantum theory of Magnetism**: Quantum theory of magnetic Susceptibility, Paramagnetism, Diamagnetism, Magnetic flux quantization, NMR, The general (one dimensional) Ising model; Partition function, Free-energy, Specific Heat and Magnetization.

7. **Quantum phenomena associated with Superconductivity**: Superconductivity; Basic experimental facts, Consequence of the Flux & Fluxoid quantization in a Superconducting ring-SQUID, Quantum Mechanical Tunnel Effect-Josephson effect and its application, Quantum resistance in Superconductor.

Books recommended

1.Many Particle Physics - G.D. Mahan
2.Quantum Field Theory of Solids-an introduction – H. Haken
3. Solid State Physics - S.O. Pillai
4. Solid State Physics - J.P. Srivastava
5. Quantum Theory of Solid - C. Kittle
6. A Guide to Feynmam Diagram - R.D. Mattuck
7. Introduction to Superconductivity (1st & 2nd Edition) - M. Tinkham

PHYS – 607: NUCLEAR PHYSICS

5 Questions **Marks – 100** **4 hours**

1.The two – body problems: Elastic scattering of spin – particles; The scattering matrix; properties of non – local separable potentials; Bound states of Non – local separable potentials; Weinber`s separable representations of the Two – body Interaction ; Local energy parameters for local potentiala.

2.Nuclear Models: Individual particle model, Basic antisymmetric states, Matrix element , Centre of mass motion, types of interactions correlation in Nuclear matter- The Brucckner method. Result for an infinite medium, Finite nuclei , Long range correlation and the ground state; Isobaric Analogue states and analogue resonance; Collective excitations of Nuclear matter , Davydov and Filippov`s model ; Nilsson potential , Collective and core excitations.

3. Nuclear Reactions: Cross – Section and the collision Matrix; The R- matrix and dispersion theory; and statistical theories: pre- equilibrium decays, Nuclear Level density; Transmission coefficients; Nuclear structure studies with neutrons; Decay of compound nucleus by particles or gamma – ray emissions; Angular distributions and angular correlations of nuclear reaction products.

4.**Optical Model:** Lane, Thomas and Wigner model; Giant Resonance; Optical Model parameters; Opties model and R- matrix: Optical model – experimental.

5. Direct Reactions: Theory of the stripping and pickup reactions; Distorted wave, Born approximation, Direct processes (Inelastic scattering or surface reaction). Multistep processes & Strong coupling.

6.Electromagnetic Interaction with nuclei: Radiative capture of thermal neutrons ;the internal conversion phenomenon ; Gamma angular correlation.

7.**.Neutron Activation Analysis :** Theoretical condiderations; Neutron activation with thermal neutrons; Fast neutron activations; Some applications analysis of environmental samples etc; Activation with particles other than neutrons.

8.Photon attenuation measurements; Theoretical background; Measurement of attenuation coefficients; Analysis of some samples.

9.Radiation Physics: Shieldings for rays and neutron; Assaying of radiations ; Application of radiations.

10.Dating of Archaeological samples: Radiocarbon dating; production of radiocarbon; half life and equilibrium level; carbon exchange reservoir; Distortions in the radiocarbon time scale; Measurement of radiocarbon; potassium – argon dating; uranium – series dating ; Theromoluminescent dating

Books recommended

1.P.B.Ray and B.P. Nigam: Nuclear Physics.
2.L.P.Kok : Factorability and the Nuclear Tree – body problem.
3.M.H.A. Pramanik: Lectures on ‘’Faddeev Formalism”
4.M.A. Preston: Physics of the Nucleus: Wesley.
5.Blatt and Weissdopf: Theoritical Nuclear Physics: John Wiley.

6.R.G . Moore Jr ; Review of Modern Physics, VR. 32 , No. 1 (1960)
7.P.A.Moldauer: Physical review, Vol 135, No. 38. 1964.
8.A.J. Farguson: Angular Correlation methods, North Holland in Gamma –ray
9.W. Hinser nd H. Feshbach, Physics Rev. 87, 366 (1958).
10.Vlado valkovic, Nuclear Microanalysis, Garland Publishing, ING.
11.Robert Cosares and Maring Giannini, Nuclear Instruments and methods 160 (1980) North Holland publishing Co.
12.M.j.Aitken, Rep . Physics 1970
13.M.j.Aitken, Rep . Physics or Archaeological Involvement of Physics, North Holland Publishing Co.
14.M.N. Islam: Application of Physics to Archaeological dating, Guest lecture at the summer science seminar in Physics Department , University of Chittagong.
15.M.K. Paul : Theory of Nuclear Structure .
16.G.R. Satcher : Nuclear Reaction.

PHYS- 608: A. SEMICONDUCTOR DEVICES AND APPLIED ELECTRONICS

(2+3) Questions **Marks – 100** **4 hours**

1. **Device Physics: Electronic properties:** Semiconductors, Intrinsic and extrinsic carrier calculation , Dopping concentration and temperature effects on Fermi- level . p-n junctions; calculation, of potential barrier and depletion width, c Shockley diode equation Junction capacitance, junction break down ,Tunnel diode, Thyrstier, Junction Transistors ; Configurations , static characteristics, Base resistance, Power transistor ,Microwave transistor FET and MOS transistor. Metal – semiconductor Junction; Contracts, Ohmic contact and Schottky contact , Schottky barrier formation , Transport mechanism , Measurement barrier height , opto – electronics; Photoconductivity, Solar cells, Basic characteristics and spectral response, LED Photo detectors, Semiconductor Lasers.
2. **Device Technology**: Sillicon extraction process , Crystal growth , Junction formation , Thermal oxidation, photolithography, Diffusion , ion implantation, Basic 1-c processes and their comparative study, realization of monolithic circuit for transistor, diode , resistance.
3. **Thin Film :** Electrical properties ; Mobility , Galvanomagnetic, Junction formation, Thermal oxidation , photolithography, Diffusion, ion implantation, Basic I- c processes and their comparative study, realization of monolithic circuit for transistor, diode, resistance.

B. APPLIED ELECTRONICS:

4. **Advances in microwaves:** Antenna types , servo- mechanisms, Remote sensing, Inter-steller & satellite Communication, Laser and fibre communication. Adances in Rader and Television systems; Channels, multiplexing Videotaping .
5. **Circuits:** Feedback and control systems, Linear systems, response, transforms analysis , random signals and noise, modulation and signaling , information and transmission .
6. **Quantum Electronics and Modern Optics:** Beam waves, optical resonators, reflective and refractive optical systems, aberrations, ray matrix techniques, Laser Physics: basis in quantum mechanics, density operator mutation, dipole interactions, rate equations, field humanization, steady state and transient modeling of laser performance, Interaction of height with phonons (Raman and Brillion scattering).Optics of crystalline media, modulation and detection of height, non linear optics. Cerenkov radiation. Losers; ceroscopy , Ridberg Atoms.
7. **Applied Acoustics:** Large amplitude vibrations, metals and non metals, fluids; forced vibration ; Sonics ranges, ultrasonic infrasonic; ceramic systemic systems; crystallinematerials ; Magnetostoictions; transduces; Aerodynamics; Vortex and turbulence; jets propulsion and aircraft operation , Mach number and sonic booms.

Books recommended

1. S .M. Size : Physics of Semiconductor devices.

2. A.S. Grove : Elements of semiconductor Physics
3. Mckeyyin : Solid state and semiconductor Physics.
4. Runyan : Sillicon semiconductor Technology.

5. Warner and Fordemwalt : Integrated Circuit design principle and fabrication.
6. Kennedy : Electronic Communication systems.
7. Keith Henny :Radio – engineering handbooks.
8. Skolnik : Introductions to Rader systems.
9. Scroggie : Foundations of wireless and Electronics .
10 H.J. Reich : Microwave principles.
11. Schwartz : information, transmission modulation and noise.
12. Carlson : Introduction to signals and noise in electrical communication.
13. Leolevi : Applied optics.
14. Arnold Sommer field : Optics . IV
15. W. Brouwer : Matrix methods in optical design .
16. Stephenson : Applied Acoustics.
17. Benson Carlin:Ultrasonics.

PHYS-609: NUCLEAR INSTRUMENTATIONS

(3+2) Questions **Marks – 100** **4 hours**

1. **Pulse Electronics:** Linear Circuits; Pulse transformers and Delay lines Transformer models, complete equivalent circuit, transformer inductances, capacitances , rise time response, practical design. Pulse shaping with delay lines, Termination of signal cables , delay lines in pulse generators.
2. **Non – linear circuits:** Diode clipping and pickoff circuits; Non- linear pulse shaping ; Pulse stretching; DC restoration problems; Transistor rating , dependence of gain of frequency , transient response, Follower circuits for signal of either polarity, the cascade amplifier , the long tailed pair; voltage and current feedback, the comparator control of stability, operational amplifier, Discriminators. The Schmitt circuits, Triggering , Scaling.
3. **Timing circuits:** Amplitude to time conversion, time to amplitude conversion; time to amplitude conversion; Diode gates , Coincidence gating and time definition , Tunnel diode- pulse shaping.
4. **Electronic Counting:** Registers read in and read out, Transfer, shifting ; Ring counters; Binary coded decimal counters; storage; decoding and code conversion; Numerical indicator tubes;
5. **Nuclear electronics:** Coincidence and anticoincidence circuits; single channel analysers; Multichannel analysers; A complete counting system; on line computing;
6. **Data reduction and error analysis techniques:** Analysis of gamma – ray spectra obtained with Nal and Ge (li) detectors ; Estimation of errors. Least squares fitting and X- test;
7. **Nuclear Detectors :**Ionisation chambers, gascous and solid state Ionisation chambers, Scintillation detectors- Scintillation mechanism, Inorganic scintillators, organic scintillators, use of dcintillation detectors for gamma – rays and neutron spectroscopy; Nuclear Track emulsion; Neutron time of flight spectrometers;
8. **Particle generator:** Neutron generator – Principle, ion sources, applications. Other sources of neutrons their spectral behaviour and uses; Linear accelerator; synchrotrons ; Magnetrons.
9. **Computing:** Languages for simple programming ALGOL &FORTRAN.

Books recommended

1. Rapheal Littauer: Pulse electronics; Mc Grow Hill Book Co
2. Millman & Taub : Pulse digital Switching wave forms;
3. C.F.G. Delaney; Eloectronics for the Physicst . Penguin books.
4. Electronic counting ; Mullard Limited- Industrial electronic division.
5. Tobey – Greeme- Huelsman ; Operationl amplifiers design & applications; Burr- Born Res . Corp . McGrawhill Co.
6. Diefenderfer; Digital electionics.
7. Nuclear Instruments and methods –Vol ,43 (1966)No.1 North Holland Publishing Co, 162 (1979) North Holland Publishing Co,

8. M.Stamley Liviogston: Particle Accelerators; Mc Graw Hill Book Co
9. Vlado Valkivic; Nuclear Microananlaysis, Garland pulishing INCC.

PHYS-610: RADIATION AND HEALTH PHYSICS

5 Questions **Marks – 100** **4 hours**

1. Sources of radiation and classification.
2. Interaction of ionizing radiations with matters.
3. Photon attenuation: theoretical and experimental measurements of attenuation coefficients, sample analysis.
4. Biological effects of radiations.
5. Philosophy and guidelines of radiation protection.
6. Ionizing radiation detectors: Ionization chamber, gas filled detectors, solid state detectors, Scintillation detectors, Neutron detectors, radiation spectrometry.
7. Analysis of gamma ray spectra from NaI(Tl), Ge(I), HPGe, liquid and plastic detectors; Estimation of errors, least square fitting and χ^2 test, Method of Monte-Carlo calculation.
8. Uses of ionizing radiation in different fields: medicine, agriculture, industry etc.
9. Radiation Dosimetry: Basic units and quantities in radiation dosimetry, Measurement of radiation doses both from internal and external sources, Dosimetry of alpha, beta, gamma and neutron radiations.
10. Environmental pollution from/by radioactive sources: radioactive pollution of air, water and other environmental samples.
11. Radiation Shielding for gamma and neutrons.
12. Radiation protection in diagnostic radiology, radiation therapy, nuclear medicine and industry.

Books recommended:

1. Introduction to Health Physics: H. Cember and T. E. Johnson.
2. An Introduction to Radiation Protection: A. Martin and S. A. Harbison.
3. Radiation Detection and Measurement: G. F. Knoll.
4. Nuclear Radiation Detection: W. J. Price.
5. Fundamentals of Radiation Dosimetry: J. R. Greening.
6. Thermoluminescence Dosimetry: A. F. McKinlay.
7. Gamma and X-ray Spectrometry with Semiconductor Detectors: K. Debertin and R. G. Helmer.
8. CRC Handbook of Environmental Radiation: A. W. Klement (Editor).
9. Environmental Radioactivity: M. Eisenbud.
10. The Atomic Nucleus: R. D. Evans.

11. Physics in Nuclear Medicine: J. A. Sorenson and M. E. Phelps.
12. Applied Radiation Biology and Protection: R. Granier, D-J. Gambini (English Translator: R. Lisker).
13. Radiobiology for the Radiologist: E. J. Hall. And A. J. Giaccia
14. Nuclear Measurement Techniques: K. Sriram.
15. Data Reduction and Error Analysis for Physical Sciences: P. R. Bevington and D. K. Robinson
16. Radiation Dosimetry: F. H. Attix and W. C. Roesch.
17. Accelerator Health Physics: H. W. Patterson and R. H. Thomas.

PHYS – 611: MEDICAL PHYSICS

5 Questions out of 8 **Marks – 100** **4 hours**

1. THE INTERACTION OF IONIZING RADIATION WITH MATTER: Absorption of energy , attenuation coefficient (Linear, Mass, Electronic and Atomic), half value layer (HVL), narrow and broad beams, energy transfer and energy absorption, photoelectric absorption, Compton scattering pair production, total transfer and absorption coefficient, total attenuation coefficient .

2. THE PRODUCTION AND PROPERTIES OF X- RAY: Definition of X-rays, requirement for production , continuous and characteristic spectra, target material, source , source size and heat production , effects of KV eland mA, power , transformers, capacitors, rectifiers, filament supply, single phase , three phase, triple factor focal spot , KV adjust, interlocks, exposure output space charge compensation overload protection, heat load indicators, warning lights, target material, measurements effects on KV and mA , heat control, line focus principle , tube rating charts, heel effect, KW rating, rotating anode, cooling, anode angle effects, abode heat capacity, filtration, added filtration inherent filtration , filtration effect on patient dose and image quality, beam limitations, light localizing collimators, different atomic no. filter, regulatory requirements, checking effectiveness. Focal spot size , magnification, penumbra, image distortion influenced by location and magnification cut off frequency, image shape as influenced by objector end target size, edge gradient, filtration smoothing filtration, contract enhancement density subtraction and addition, recording, tape, film , disk, video output, system gain , spatial resolution, speed, brightness, efficiency, size and visibility , fog, contrast resolution, vessel receptors viewing variables.

3. MODERN IMAGING TECHNIQUES: CT SCANNING: Introduction, basic concepts, display, detectors, ring artifact, calibration of detectors, scattered radiation, X – ray tube, CT image, backprojection, convolution, artifacts, spectral artifacts. CONVENTIONAL TOMOGRAPHY: Principles of operation types of motion, slice thickness and orientation, artifacts topographic synthesis. MAGNETIC RESONANCE IMAGING: Basic concepts, Basic NMR experiments, relaxation, image concepts, pulse sequence, hardware, image artifacts acceptance tenting and quality control. FLUOROSCOPY: Basic principles of digital systems basic principles of luminescence, image intensification, design brightness, flux gain and minification dose. MAMOGRAPHY: Contrast, resolution, serene film mammography, xeroradiogaphy, doses, risk. ANGIOGRAPHY: Digital subtraction, magnification, radiation doses.

4. PHYSICS IN NUCLEAR MEDICINE: Basic concepts, applications, scanning, radio nuclides, uptake machine, gamma camera, basic performance checks, Biological and effective half-life, radiation hazards. Radioactive decay Radio nuclides, activity, exponential decay, decay factors, parent daughter decay. Reactor produced Radio nuclides, accelerator produced radinuclides, photonuclear activation, equations for radio nuclide production, radinuclide generators . Nal (T) well counter, semiconductor detector system, liquid scintillation counter, the Anger Camera, Uptake Machine, Spatial resolution contrast, noise, quality assurance of imaging instruments.

5. RADIOTHERAPY: Kilovoltage units Grenz ray therapy, contract therapy, superficial therapy, Orthovoltage or Deep therapy, supervoltage therapy, Van de Graaf generator, linear Accelerator, Belatron, Microtron, Cyclotron, Cobalt 60 unit, cesium 137 unit. Absorbed Dose and Karma, Energy fluence and Exposure, the Bragg- Gray cavity, exposure, practical Ion chamber, saturation in Ion chamber, efficiency, absolute Ion chamber, effects of temperature and pressure on Ion chamber determination of absorbed dose in ``Free pace'' and in a phantom, solid state detectors, thermo luminescent dosimetry (TLD), chemical dosimetry, film as a dosimeter, the calorimeter (Direct measurement of absorbed dose). Depth dose distribution percentage depth dose (PDD) Backscatter factor, Ralationship between TAR and percent depth dose, conversion of PDD, Scatter air ratio. Dose calculation parameters, collimator sxatter correction factor phantom correction factor , TMR, SMR, SSD techniquesisocentric techniques and irregular field dose calculation in irregular field dose calculation in irregular field Clarkson`s method. Isodosechart , Isodose curves beam quality Penumbra effect, collimation and flattening factor, wedge systems, combination of radiation fields , multiple field, lsocentric techniques, wedge field techniques, Tumor dose specifications. Acquisition of patient data, corrections for contour irregularities. Corrections for tissue inhomogeneties, Absorbed within an inhomogeneity, tissue compensations. Patient positioning . Field Blocks, A system of field shaping , skin dose , methods of field separation.

Electron interactions electron scattering, energy specification and measurement, Determination of absorbed dose, depth doses distribution, Characteristics of clinical Electron beams, treatment planning, field shaping, and electron are therapy total skin irradiation.

6. THE CELL AND RADIATION: Basic structure, function, phases of cell cycle, cell cycle time , enzymes, sensitivity, DNA and replication , chromosome aberrations, genes genetic mutations , Reproductive integrity, the in – vibro survival, curve, the shape of survival curve, the in – vivo survival curve, radiation induced chromosomes aberrations. Normal tissue system, pig skin, rodent skin , the lung, the oesophagus the kidney, the nature of oxygen effect, oxygen acts time, mechanism and importance in clinical therapy. The deposition of radiant energy linear energy transfer, relative biological effectiveness, RBE for different cells and tissues. Lethal, potentially lethal and sublethal radiation damage, the dose rate effect , radio sensitivity in the mitotic cycle. Solid tumor systems and reoxygenating, cell, tissue, and tumor kinetics, time dose and fractionation. Non- specific life shortening and carcinogenesis, genetic changes, effects on the Embryo and Fetus .

Books recommended:

1. H. E. Johns and J. R. Cunningham- The Physics of Radiology
2. T. S. CURR & Others- Christensen`s Introduction to the Physics of Diagnostic Radiology .
3. Steve Webb physics of Medical Imaging.
4. W. N. Diken – Diagnostic Ultrasomography
5. W. Stuart and N. Yong –MRI Principles
6. Glenn F. Knoll- Radiation Detection and Measurment .
7. Frand Herbert Attix- Introduction to Radiological physics and Dosimetry.
8. Faiz M. Khan- Physics of Radiotherapy
9. E. J. Hall and A. J. Giaccia– Radiobiology for the Radiologist.
10. R. L. Keterin- Radiation Protection.
11. James A. Sorenson and Michael E. Phelps- Physics of Nuclear Medicine.
12. P. Uma Dev- Introduction to Radiation Biology.

13 Faiz M. Khan- The Physical Principles of Medical Imaging.

PHYS – 612: BIOLOGY AND PHYSICS OF HUMAN BODY

5 Questions out of 8 Marks – 100 4 hours

1. ANATOMY OF HUMAN BODY: GROSS ANATOMY – Organization of the human body – history of anatomy , anatomical terminology , position regional names, directional terms, body plans, body cavities and their subdivision, principle systems of the human body structure, skeletal system, muscular syster, integuementary; system, vessels (arteries, capillary, venous and Lymphatic), respiratory; system, digestive system, urinary system, reproductive system , anatomical presentation by imaging systems (conventional radiographic , topographic anatomy, digital auto- radiography, ultrasound, radio- nuclide). EMBRYOLOGY-Introduction, intrauterine development , general and special embryology, congenital malformation and resk factors and elementary lnowledge of human genetics, HISTOLOGY- Structural organization: the cell (composition, division , cycle), tissue (concept, classification, distribution and function of the tissue epithelial, nuscular, connective and nervous), Skin and it`s derivatives, endocrine system, reproductive system, urinary system, digestive system the eye and the ear.

2. PHYSIOLOGY OF HUMAN BODY: GENERAL –The aim o the course is to provide human physiology those involved in medical electronics of function effectively in hospital environment. The lectures will also cover a range of clinical meadurements techniques such as those found in obstetrics, cardiology, neurophysiology and respiratory medicinc. The application and design of therapeutic equipment icluding infusion devices, resuscitation equipment, real dialysis technology will also cover in addition to physiology if the following. RESPIRATOTY SYSTEM- Pulmonary, ventilation, pleural fluid , diffusion of oxygen and carbon dioxide, regulation of respiration, respiratoty insufficiency. EYE AND EAR-physiology of hearing and equilibrium , eyeball and visual physiology. Endocrine system- Function and mechanism of hormonal action CARDIOVASCU 8LAR SYSTEM- respiration and it`s control, pulmonary ventilation air volumes and capacities, gas exchanges and transport. DIGESTIVE SYSTEM AND METABOLISM- characteristics of alimentary canal , tube movement, enervation, mixing and emptying action of stomach, gadtric secretion and absorption, Metabolism- anabolism, carbogydrates, enzymes, body heat and temperature regulation of the supporting organ`s (pancreas, gall bladder, live and intestives)of the digestive system. URINARY SYSTEM- water, electrolyte and acid/base balance, body fluids compartments, compositions, balance and movements. REPRODUCTIVE SYSTEM – physiology of the spermatogenesis, menstrual and ovarian cycles, pregnancy and ovarian cycles, pregnanc and function of the mammary glands. NERVOUSSYSTEM- nerve impulses nerve conduction, signal transmission.

3. BIOMOLECULES: Structure and metabolism of protein, carbohydrate, lipid, nucleotide and nucleic acids. Enzyme kinetics and mechanism of enzyme action. Structure of bio-molecular members, constituents, biosynthesis and topography of membranes. Introduction to gene technology, restriction enzymes, DNA clining, DNA sequencing, construction of DNA libraiies. Laws of thermodynamics, heat, work and energy . Solutions of macromolecues: Thermodynamics of solutions, membrane epuilibria, transport aacross membranes. Separation, purification and characterization of macromolecules, Gel filtration, electric field, viscosity.

Absorption and emission of radiation, scattering, circular dichroism and optical radiation, X-ray diffraction.

4. PHYSICS OF HUMAN BODY: FORCE IN BODY – Static`s frictional forces, Dynamics. PHYSICS OF THE SLELETON –What is done made low strong are the bones? Lubrication of bone joint, Measurement mineral in body. HEAT AND COLD IN MEDICNE-phsical basis of heat and temperature, thermometry and temperature scales, Thermograph- mapping the bodies temperature, heat thrapy, Use of cold in medicine, Cryosugery, Safety with cryogenics. ENERGY, WORK AND POWER IN THE BODY- Consernation of energy in the body, Energy changes in the bodywork and power, Heat losses from the .PRESSURE IN THE BDY- Measurement of pressure in the , pressure inside the skill Eye pressure,Pressure in the digestive system, in the skeleton and in the urinary bladder , Pressure effect while diving, Hyperbolic oxygen therapy. PHYSICS OF THE LUNGS AND BREATHING- The aireays How the blood andlungs interact, physics of the alveoli, The breathing Physics of some common lung diseases. PHYSICS OF THE CARDIOVASCULAR SYSTEM –Major components of cardiovascular system. O_2 and CO_2 exchange in the capillary system, Work dove by the heart, Blood pressure and it`s measurement , Pressure across the blood
vessel wass, Bernoulli`s principle applied to the cardiovascular system, How fast does your blood flow? Blood flow – laminar and turbulent, Heart sounds, The physics of some cardiovascular diseases, some other functions of blood. CARDIOVASCULAR INSTRUMENTS –Bio – potcntials of the hcart, Electrodes, Amplifiers, patient monitoring Defibrillators, pacemakers. ELECTRICTTY WITIN THE BODY-the nervous system and the neuron , electrical potentials of nerves Electrical signals from muscles, heart, brain and eye , Magnetic signals from heart and brain.PHYSICS OF THE EAR AND HEARING-The outer, inner and middle ear, Sensitivity of the ears , Testing of hearing Deafiness and hearing aids. LIGHT IN MEDICINE – Measurement o light and it`s units, Application of visible light, Ultraviolet, infrared light in medicine, lascrs in mcdicine, Application of mmicroscopcs in mcdicinc. PHYSICS OF THE EYE AND VISION- Focusing elements and some sther elements of the eye, How sharp are your eyes? Optical illusions and related phenomena, Depective vision and chromic aberration Instruments used in ophthalmology. HYPERTHERMIA PHYSICS- Basic principles and monitoring, cellular and biological effects of hyperthermia therapy, effects in tumor and normal tissues, hyperthermia planning.

Books recommended:

1. B. D. Chaurasia: Human Anatomy.
2. K. S. Saladin: Human Anatomy.
3. M. McKinley and V. D. O'Loughlin: Human Anatomy.
4. W. J. Hamilton: Textbook of Human Anatomy.
5. Silverthorn: Human Physiology, An Integrated Approach.
6. H. S. Ravikumar, H. K. Makari, H. Gurumurthy and S. V. Sowmya: A Text Book of Human Physiology.
7. L. Landois: Textbook of Human Physiology.
8. S. I. Fox: Human Physiology.
9. S. P. Bhutani: Chemistry of Biomolecules.
10. P. Davidovits: Physics in Biology and Medicine.
11. J. R. Cameron and J. G. Skofronick: Medical Physics.

PHYS- 613 : GRAVITATIONAL PHYSICS

5 Questions **Marks- 100** **4 hours**

1. Black holes : Formation mechanism of black holes, laws of black hole dynamics, black hole solutions in Schwarzschild and Eddington-Finkelstein co-ordinates, light cones of the Schwarzschild geometry, geometry of the horizon and singularity, black holes in X-ray binaries, black holes in galaxy centers, solution of the Kerr black hole, detection of black holes and Hawking radiation.

2. Scalar-tensor theories : Nordström's theory, Jordan's theory. Mach's principle, Brans-Dicke theory, weak field solution, energy-momentum conservation, conformally covariant physics, conformally covariant derivatives, Lagrangian and field equations.

3. Wormholes : Classification of wormholes, embedding diagram, properties of traversible wormholes, mathematical details of traversible wormholes: form of the metric, equations of structure for the wormhole, the stress-energy tensor, boundary conditions, tidal gravitational forces and time to traverse the wormhole, the stress-energy that generates the wormhole's spacetime curvature, seven energy conditions, Static aspheric wormholes: Minkowski surgery, cubic wormholes, Dynamic spheric wormholes: Schwarzschild surgery, Einstein equations, static wormholes and dynamic wormholes.

4. Gravitational waves : The linearized Einstein equation with sources, solving the wave equation with source, the general solution of linearized gravity, production of weak gravitational field, gravitational radiation from binary stars, the quadrupole formula for the energy loss in gravitational waves, effects of gravitational radiation detected in a binary pulsar.

Books Recommended :

1. Eric A. Lord — Tensors, Relativity and Cosmology
2. S. K. Bose — An introduction to General Relativity
3. Jayant V. Narlikar — Lectures on General Relativity and Cosmology
4. James B. Hartle — Gravity : An introduction to Einstein's General Relativity
5. Peter G. Bergmann — An introduction to the Theory of Relativity
6. R. Adler — An introduction to General Relativity
7. Matt Visser — Lorentzian Wornholes - From Einstein to Hawking
8. Steven Weinberg — Gravitation and Cosmology: Principles and applications of the General Theory of Relativity
9. M. S. Morris & K. S. Thorne — Wormholes in spacetime and their use for interstellar travel: A tool for teaching General Relativity

PHYS- 614: Semiconductor Physics and Superconductivity

(2+3) Questions Marks – 100 4 hours

Group-A: Semiconductor Physics

1. **Introduction**: Energy Bands in Semiconductors, Intrinsic Semiconductors, Extrinsic Semiconductors and their Important Properties, Statistics of Electrons and Holes in Intrinsic and Extrinsic Semiconductors.
2. **Conduction Mechanism**: Theoretical Study of Electrical Conductivity, Mobility of Current Carriers, Hall Effect, Susceptibility, Calculation of Band energy in Different Types of Semiconducting Materials.
3. **Semiconductor Devices**: P-N junction, Characteristics, Effect of Temperature on P-N Junction Diode, Some Special P-N Junction Diode; Zener Diode, Tunnel Diode, LED, Solar cell, Transistors, Optical and photoelectrical Phenomena in Semiconductors.
4. **Application of Semiconductors**: Semiconductors in Computers, Microelectronic Circuits, Micro Electromechanical Systems (MEMS), Quantum Dots (QDS), Spintronics.

Group-B: Superconductivity

5. **Basic Experimental Observations**: Resistivity, Transition Temperature, Perfect Diamagnetism, Specific Heat, Critical Magnetic fields, Characteristics lengths in superconductor, Magnetic Flux Quantization, Josephson Effect in Superconductor.
6. **Superconducting Materials**: Low-T_c Superconductivity; A-15 Superconductors, Superconducting Alloys and Compounds, High- T_c Superconductivity, Oxide superconductors, Fullerenes Superconductors, Non-oxide Superconductors and their Structural Aspects, Recent Development of High- T_c Superconductivity.
7. **Fundamental Theories of Superconductivity**: Introductory concept of London Model, Two-Fluid Model, BCS Model, G-L model, Theories of High-temperature Superconductivity; Anisotropic Ginzburg-Landau Model, Lowrance-Doniach Model, RVB Model.
8. **Fluctuation Effect**: The Time Dependent G-L Equation for Fluctuation Phenomena in Superconductor; Fluctuation Heat Capacity, Diamagnetism, Thermal Conductivity, Anderson phase- slip events, Critical Currents.
9. **Advanced Topic in Superconductor**: Paraconductivity-Definition, Theoretical Model, Calculation of Paraconductivity and its measurement techniques, Paraconductivity and its related Parameters for HTSCs, Magnetic Relaxation in HTSC, Technological Application of Superconductivity; Energy Storage Technology (SMES,TES), SQUID- Technology in Medical Sciences.

Book recommended

1. Solid State physics- S.O. Pillai
2. Solid State Physics- J.P. Srivastava
3. Modern Physics- S.L. Kakani and S. Kakani
4. Theory of Superconductivity- M. Crisan
5. Superconductivity – Jr. C.P. Poole, H.A. Farach and R.J. Creswick.

6. The Physics of Superconductors – V.V. Schmidt
7. Introduction to Superconductivity (1^{st} and 2^{nd} Eds.) – M. Tinkham
8. Theory of Fluctuation Effect in Superconductors – A. Larkin and A.A. Varlamov
9. Superconductivity and Superfludity (3^{rd} Ed.) – D.R. Tilley and J. Tilley
10. Superconductivity-an introduction –M.R. Islam (unpublished).