PHYSICS (PH) COURSES

PH 103 APPLIED PHYSICS IN BIOLOGY 3 UNITS

Objectives

At the end of the course a student will be able to:
Relate relations of concepts and principles using dimensions and units;
Derive the relationships between potential, potential energy, force and fields.
Explain the physics flow of fluids in pipes and solids in fluids
Explain and quantify molecular separation by sedimentation and centrifugation;
Explain the origins of the forces responsible for separation of charged and neutral particles by gel and capillary electrophoresis.
Explain the origins NMR spectra and what it stands for in a given molecular environments.

Content

Introduction: Dimensions and units, dimension analysis, mathematics of NMR. **Mechanics:** kinematics, vectors, dynamics and angular quantities, properties of fluids, equation of continuity, friction and drag in fluids. **Fluids**: Poiseuille's equation, blood velocity and turbulence; **Electricity:** Coulomb and gravitational forces**,** relationship between electrostatic, electric field, electric potential, electric potential energy, and electric current; membrane potentials, circuit topology, and capacitor and RLC Circuit and applications to NMR spectroscopy. **Electron microscope:** Principles (comparison between light and electron microscope, particle wave duality, electron optics, and electron lenses) and design (electron gun, condensed lens, lens aberrations, objective lens and specimen stage). **Electrophoresis**: principles of gel and capillary electrophoresis, modes of molecular separation and advantages, and factors that influence separation resolution. **NMR Spectroscopy**: Nuclei with spin, energy levels, transition energy, energy level diagram, Boltzmann statistics, T1 and T2 processes, Fourier transform, spin relaxation, spin exchange, chemical shift, and NMR spectroscopy. **Lasers:** The physics of lasers and applications to biology.

Delivery: 45 hours of of lectures, 15 hours of tutorials.
Assessment*:* 40% Coursework; 60% final examination.

Textbook

Catnell J. D. and Kenneth W. J., Physics 6th Edition John Wiley and Sons (2004).
Giancol DC: Physic: Principles and Applications 6th Edition Prentice Hall (2005).
Hornak JP, The Basics of NMR, on line textbooks; http://www.cis.rit.edu/htbooks/mri/

Reference

Kane J. W. and Sternheim M. M., Physics, John Wiley & Sons, New York, (1980).
Nolan J.P. Fundamentals of College Physics. W C. Brown (1993).

PH116 EXPERIMENTAL METHODS OF PHYSICS I 2 UNITS

Objectives*:*

By the end of the course the student should be able to:
Measure correctly the basic physical quantities of mass, length, time and current.
Determine errors in measurements.

Analyze raw data and make valid conclusions.
Validate corresponding theoretical component.

Content:
A selection of physics experiments chosen to consolidate and extend the student's understanding of the lecture courses and to emphasize the experimental basis of Physics. Emphasis is placed on measuring skills, data handling and treatment of errors in experimental measurement.

Delivery: 90 practical hours (Two 3-hour laboratory sessions per week.)
Assessment: Laboratory reports 100%.

References:
Laboratory manual/experiment sheets and relevant textbooks.

PH 122 CLASSICAL MECHANICS 2 UNITS
Objectives*:*
By the end of the course the student should be able:
To solve and determine the dynamical behavior of discreet mechanical systems.
To apply Newton's Laws and the Lagrangian method.
To apply the laws governing the conservation of energy; momentum; and angular momentum.

Content*:*
Newtonian Mechanics; Vectors algebra and applications; Single particle dynamics; Conservation Laws; Gravitation and Kepler's laws. Introduction to Lagrangian Mechanics: Calculus of Variations; Lagrangian and Hamiltonian dynamics; Central force motion; Motion in a non-inertial reference frame; Systems of Particles; Coordinate rotation and matrices; Rigid bodies.

Delivery*:* 30 hours of lectures, 15 hours of tutorials
Assessment*:* 40% Coursework; 60% final examination.

Textbooks*:*
Fowler G. R., Analytical Mechanics, 5th Edition, Saunders College Publishing, (1995).

References:
Halliday D, Resnick R, Krane K.S. Physics Vol I, John Wiley & Sons (1992).
Nolan J.P. Fundamentals of College Physics. W C. Brown (1993).
J. Marion and S. Thornton, Classical Dynamics of Particles and Systems, Holt Rinehart & Winston (1995).

PH 127 VIBRATIONS,WAVES AND OPTICS 3 UNITS
Objective
By the end of the course the student should be able to:
Explain the basic principles of wave motion, vibration and oscillations.
Apply Newton's laws to formulate the physical problems for free, forced, damped and coupled oscillations;
Make the correlations between mechanical and electrical oscillations;
Apply the concept of oscillations and waves in practical situations.

Content*:*

Oscillations: simple and damped harmonic motion; coupled oscillations; forced oscillations and resonance. **Wave motion**: The wave equation and its solutions; Phase velocity and group velocity; Theoretical description of plane and spherical waves; Doppler effect; Ultrasonic and infrasonic sounds and their applications. Optics: Light sources and detectors; Snell's law; Fermat's principle, total internal reflection, Spherical mirrors and refracting surfaces, lens aberration. Interference; Young's double slits, Newton's rings, Michelson and Fabry-Perot interferometers; Diffraction: Fresnel- and Fraunhoffer-type diffraction; Diffraction gratings; Polarization; Holography, Elements of quantum optics.

Delivery: 45 hours of lectures, 15 hours of tutorials
Assessment: Course work 40%, final examination 60%.

Textbooks:
Pain H.J., The Physics of Vibration and Waves, Fifth Ed., Wiley. (1999).
Jenkins F.A. and White H.E. Fundamentals of Optics, McGraw-Hill, Auckland, (1976).

References:
Halliday D, Resnick R, Krane K.S. Physics Vols I & II, John Wiley & Sons (1992)
Bajaj N.K. The physics of waves and oscillations. Tata McGraw-Hill (1998)
French A.P,. Vibrations and Waves. Chapman & Hall, (1990)
George H., the Physics of Waves, Prentice Hall. (1992)
Hecht, E. Optics, 3rd Ed., Addison–Wesley, (1998)
.Young, H.D. and Freedman, R.A. University Physics With Modern Physics, 10th Ed., Longman HE (2000).
Tipler, P.A. Physics for Scientists & Engineers, Worth, (1998).
Saleh B.E.A. and Teich, M.C. Fundamentals of Photonics, Wiley, (1991).

PH 128 ELECTROMAGNETISM 3 UNITS

Objectives
By the end of the course the student should be able to:
Explain the concept and structure of the electric field;
Represent electromagnetic field phenomena mathematically for different situations;
Analyze and solve various electric circuit problems;
Explain electromagnetic induction and its applications;
Apply methods of vector calculus in advanced treatment of electromagnetic phenomena.
Understand the behaviour of EM waves in different media and at interfaces.
Apply Maxwell's equations in solving practical problems

Content:
Electric charge, Coulomb's law, Electric field, Gauss' law, electric potential and capacitance; Current electricity, DC circuits, Kirchhoff's laws and transients. Magnetic fields, Ampere's and Faradays laws, force on a moving charge, Lorentz law. Electromagnetic (EM) field, inductance and ac circuits. Electric and magnetic vectors: electrostatics and magnetostatics as examples of zero curl. Dielectric materials, media; Reflection and refraction at an interface (Fresnel's equations) scattering of electromagnetic waves; waveguides. Applications of EM waves and radiation antenna.

Textbook
1. Halliday D, Resnick R, Krane K.S. Physics Vol II, John Wiley & Sons (1992).

2. Lorrain P. and Corson D.R., Electromagnetic Fields and Waves, 2nd edition, W.H. Freeman and Company, (1970).

Reference
Nolan J.P. Fundamentals of College Physics. W C. Brown (1993).

Delivery: 45 hours of lectures and 15 hours of tutorials
Assessment: Coursework 40%, final examination 60%.

PH 202MATHEMATICAL METHODS OF PHYSICS 3 UNITS

Objectives:
Upon completion of this course the student should be able to:
Express a physical system in terms of different coordinate systems
Apply various mathematical techniques in solving various physical systems
Solve differential and integral equations describing physical systems.

Content*:*
Coordinate systems: Cartesian, spherical, polar, circular, cylindrical. Vector calculus, gradient, divergence, curl, integration, Gauss and Stoke's theorems; partial differential equations, Laplace equations, Poisson's equation, the diffusion equation, the wave equation-separation of variables, series solution, matrices, determinants, orthogonal, hermitian and unitary matrices, diagonalization of matrices. Partial differential equations; Fourier series; Boundary value problem of Sturnm and Liouville; Legendre equations and polynomials; Series solution of important differential equations, Bessel equation and functions; Fourier Integral and transform, Laplace transform. Applications to physical problems.

Delivery*:* 45 hours of lectures, 15 hours of tutorials
Assessment*:* 40% Coursework; 60% final examination.

Textbooks:
Arfken G., Mathematical Methods of Physics, Academy Press, (1966).
Kreyzig E., Advanced Engineering Mathematics, 6th Edition, John Willey & Sons, (1988).

References:
Boas M.L., Mathematical methods in the Physical Sciences, 2nd edition, John Willey & Sons, (1983)

PH 203: RADIATION PHYSICS IN BIOLOGY AND AGRICULTURE 3 UNITS

Objectives*:*
At the end of the course a student will be able to:
Explain the origins of all nuclear radiations, radioactivity, interaction of radiation with matter, and methods of detection.
Describe the origins of health effects of radiation and how they relate to radiation biology and protection.
Relate several nuclear radiation technologies to applications in tracer techniques and improved availability and quality of food in agriculture.

Content*:*

Nuclear Radiation Physics: Sources of nuclear radiations, radioactivity, interaction of radiation with matter, detection and measurements of nuclear radiation. **Radiation Biology:** deterministic and stochastic effects of ionizing radiation on biological systems, risk model for cancer induction, radiation mutation and carcinogenesis, radioactive waste and pollution, and internal irradiation. **Radiation Safety Standards**: Concepts and principles of nuclear law and radiation safety standards; **Applications:** Tracer kinetics, soil and fertilizer nutrient assessment, disease control in plants, insect control, crop production, animal nutrition, radioimmunoassay, vaccines attenuation, and food preservation.

Delivery: 45 hours of lectures, 15 hours of tutorials.
Assessment*:* 40% Coursework; 60% final examination.

Textbook
Shuler J. M. ; Understanding Radiation Science: Nuclear and Health Physics Universal Publishers (2006).

References:
Lowenthal G. and Airey P. Practical Application of Radioactivity and Nuclear Radiations Cambridge University Press (2001).
Hall E. J. and Giaccia AJ. Radiobiology for the Radiologists Lippincott Williams & Wilkins, (2006) 6^{th} Edition.
Steel G. G. Basic Clinical Radiobiology Hodder Arnold (2002) 2^{nd} Edition.

PH 217 QUANTUM PHYSICS 3 UNITS
Objectives*:*
By the end of the course a student should be able to:
Explain the failures of classical physics and the origin of the quantum theory.
Relate Bohr theory to the de Broglie hypothesis.
Interpret and apply the wave function to simple quantum mechanical systems.
Explain the theoretical framework of quantum mechanics;
Apply the theoretical framework of quantum mechanics to physical problems;
Describe the basics of relativistic quantum mechanics.

Content*:*
Experimental basis for quantum mechanics; wave-packets; uncertainty principle. Hilbert space formalism. Schrödinger equation: eigenvalues and eigenvectors: applications to 1-D problems including the infinite and finite potential wells and the harmonic oscillator, tunneling and time independent perturbation theory. Angular momentum and spin operators. Operator methods in quantum mechanics. Coupling of spin and angular momenta. Variational principles and elements of time dependent perturbation theory (the Golden Rule). Solution of the Schrödinger equation in three dimensions. Applications to the hydrogen and helium atoms and to simple problems in atomic and molecular physics. Introduction to relativistic quantum mechanics.

Delivery*:* 45 hours of lectures, 15 hours of tutorials.
Assessment*:* 40% Coursework; 60% final examination.

Textbooks*:*
Liboff R., Introductory Quantum Mechanics, Addison Wesley (1997).

Eisberg R. and R. Resnick, Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles 2nd Edition, John Wiley, (1985).
Anderson E. E., Modern Physics and Quantum Mechanics; W.B. Sounders, (1971).

References:
Kiwanga, C.A., Quantum Mechanics, The Open University of Tanzania, (2001).
Beiser A., Concepts of Modern Physics, 6th Edition, McGraw-Hill (1995).
Haken H. and Wolf H.C., Physics of Atoms and Quanta, Springer, 6th Ed., (2000).
Basdevant J.L. and J. Dalibard, Quantum Mechanics Solver: How to Apply Quantum Theory to Modern Physics. Springer-Verlag, Berlin, (2000).

PH220 STATISTICAL THERMODYNAMICS 2 UNITS

Objectives:
At the end of the course the student should be able to:
Demonstrate understanding of the basic concepts of statistical mechanics and thermodynamics.
Apply statistical mechanics and thermodynamics concepts to a variety of physical phenomena.

Content*:*
Specification of state of a system; Equation of state, principle of equal *a priori* probabilities; reversibility and irreversibility; density of states. Thermal interaction between macroscopic systems, the zeroeth law, specific heat capacities, isothermal and adiabatic processes, Heat and work: Macrostates and microstates, microscopic interpretation of work, quasi-static processes, exact and inexact differentials, first law of thermodynamics. Entropy and the second law of thermodynamics heat engine and refrigerators, thermodynamic potentials. Applications of statistical thermodynamics to a variety of physical phenomena. Fermions and Bosons distribution functions, density of states, classical limit, Maxwell distribution of velocities, Einstein condensation.

Delivery*:* 30 hours of lectures, 15 hours of tutorials.
Assessment*:* 40% Coursework; 60% final examination.

Textbook*:*
Ashley H. Carter, Classical and Statistical Thermodynamics, Prentice Hall (2001).

References:
David S. Betts and Roy E. Turner, Introductory Statistical Mechanics, Addison-Wesley (1993).
D.V. Schroeder, An Introduction to Thermal Physics, Addison-Wesley, (2000)
R. Baierlein, Thermal Physics Cambridge University Press, (1999).

PH 222 ADVANCED MECHANICS 2 UNITS

Objective:
By the end of the course the students should be able to:
Solve more advanced problems in Mechanics;
Apply the Lagrangian method;
Explain the basic principles of special relativity.

Content
Vectors and coordinate transformation, conservative forces and the potential energy function, non-inertial reference frames, central forces and the motion of planets, Lagrangian mechanics; Special Relativity: Relativistic kinematics, space-time and relativistic dynamics

Delivery: 30 hours of lectures and 15 hours of tutorials.
Assessment: Coursework, 40%, final examination 60%.

Textbooks
H. Goldstein. Classical Mechanics, 2nd edition Addison-Wesley Publishing Company Inc (1980)

References:
G. R. Fowler Analytical mechanics 5th edition, Saunders College Publishing (1995).
Murray R. Spiegel, Theoretical Mechanics, Schaum's Outline series in Science, McGraw-Hill Book Company (1967).
W. Pauli, Theory of Relativity, Dover Publications Inc , New York (1981)

PH 229 COMPUTATIONAL PHYSICS 2 UNITS

Objectives*:*
By the end of the course the student should be able to:
Effectively use programming packages like MATLAB
Create simple computer programs using standard language (C or Fortran);
Solve various algebraic, ordinary differential, and partial differential equations by employing various numerical methods and
Effectively display data and computational results.

Content:
Computer programming essentials: An overview. Computational techniques including: root finding using the Newton-Raphson method; Interpolation using the least squares fitting, Solving ordinary differential equations using the Runge-Kutta method and partial differential equations using finite difference and finite element techniques; random number generation and the Monte Carlo methods, Spectral analysis using fast Fourier transforms. Working with matrices; solutions to linear equations; eigenvalue and eigenvector calculations; Numerical integration and quadrature.

Delivery*:* 60 practical hours, computer laboratory based**.**

Assessment: 100% Continuous Assessment in the form of projects.

Textbooks
Burden and Faires: Numerical Analysis, Pws-Kent Publishing Company, (1993)
Brian W. Kernighan and Dennis M. Ritchie: The C Programming Language, (1995)

References:
Bajpai , Calus and Fairley: Numerical Methods of Engineering and Scientists, John Wiley & sons, Chichester, (1976)
J. Konvalina and S. Wileman (1987). Programming with Pascal. Singapore, McGraw-Hill.
Judy Bishop :Java Gently Programming: Principle Explained, 2nd Edition. (1998)
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PH 247 EXPERIMENTAL METHODS OF PHYSICS II 2 UNITS

Objectives*:*
By the end of the course the student should be able to:

Translate theory into experimental set-up.
Write standard scientific report.
Relate experimental results with corresponding theoretical courses.

Content:
A selection of advanced physics experiments chosen to consolidate and extend the student's understanding of the lecture courses and to emphasize the experimental basis of Physics. To advanced students skills in data handling, treatment of errors in experimental measurement and scientific report writing.

Delivery: 90 hours of practicals (Two 3-hour laboratory sessions per week).
Assessment: Laboratory reports 100%.

References:
Laboratory manual/experiment sheets and relevant textbooks.

PH 249: FUNDAMENTALS OF MATERIALS SCIENCE 2 UNITS

Objectives*:*
By the end of the course the student should be able to:
Explain the relationship between structure and properties of materials;
Relate properties and practical applications of materials.

Content:
Classes of materials: Metals, ceramics, polymers, glasses and composites. **Structure of materials**: Atomic structure; electronic structure; inter-atomic bonding; crystal structure, crystal defects, phase transitions and phase diagrams. **Properties of materials**: Mechanical properties: elasticity, plasticity, fatigue and fracture, dislocations and their interactions with other lattice defects; Electric, magnetic, thermal and optical properties of materials; microstructure-property relationships. **Metals**: Ferrous alloys: Crystal structure, iron/carbon systems, steel, cast iron, microstructure and heat treatment. **Ceramics**: Structure, production/processing, properties, toughening. **Polymers**: Chemical structure, thermoplastics, thermal setting, elastomers, polarity, mechanical characteristics and special plastics. **Composite materials**: Types, structure and properties, applications.
Environmental effects: Corrosion and wear, prevention. **Application:** Examples of practical applications, for example solar energy materials, etc.

Delivery*:* 30 hours of lectures, 15 hours tutorial.
Assessment*:* 40% Coursework; 60% final examination.

Textbook*:*
William D. Callister, Jr. Fundamentals of Materials Science and Engineering: An Integrated Approach. 2nd Edition, Wiley, (2005).

References*:*
James F. Shackelford, Introduction to Materials Science for Engineers, 4th Edition, Prentice Hall, (1995).
Oliver H. Wyatt and David Dew-Hughes, Metals, Ceramics and polymers: An Introduction to the Structure and Properties of Engineering Materials. Cambridge University Press, (1974).
Lawrence H. van Vlack, Elements of Materials Science, 2nd Edition, Eleventh Printing, Addison-Wesley Publ. Co., (1974).

Lawrence H. van Vlack , Materials Science for Engineers. Addison-Wessley Publ. Co., (1970).

PH 312 ELEMENTARY PARTICLES 2 UNITS

Objectives:
By the end of the course the student should be able to:
Explain the basis and foundations of particle physics.
Describe the standard model.
Distinguish among the different elementary particles.
Explain the theories on the unification of the fundamental forces.

Content:
Historical perspective of hadrons: An overview. Elementary (or fundamental*)* particle, definition, Particle interaction: The four basics forces; Gravitational, the weak, the strong and the electromagnetic forces. Family of particles and the Standard model, fermions and bosons, incompatibility with Einstein's general relativity . Thegrviton and the E-particle. Fundamental fermions: Quarks, leptons, neutrinos, muons and tau lepton. Quarks model: Quarks and antiquarks Quark and colour charges, antiquarks and anticolor. Quarks and electric charges. Fundamental bosons; Gluons. Beyond the Standard model: Grand unification theory. Supersymmetry; String theory; Preon theory.

Delivery: 30 hours of lectures, 15 hours of tutorials.
Assessment: 40 % Coursework and 60% Final examination.
Textbook*:*
Griffiths D. J., Introduction to Elementary Particles. Wiley, N; (1987).

References*:*
Gribbin, J. Q is for Quantum - An Encyclopedia of Particle Physics. Simon & Schuster. (2000). (ISBN 0-684-85578-X)
Clark, John, E.O. The Essential Dictionary of Science. Barnes & Noble. (2004). (ISBN 0-7607-4616-8)
Veltman, Martinus . Facts and Mysteries in Elementary Particle Physics. World Scientific. (2003). (ISBN 981-238-149-X)
Feynman, R.P. & Weinberg, S. Elementary Particles and the Laws of Physics: The 1986 Dirac Memorial Lectures, New York: Cambridge University Press (1987).

PH 317 FUNDAMENTALS OF ELECTRODYNAMICS 2 UNITS

Objectives:
At the end of the course, the student should be able to:
Derive fundamental electromagnetic field equations,
Derive equations that are used in describing propagation of plane electromagnetic waves in conducting and non conducting media,
Develop fundamental mathematical relations that are used to describe the propagation of electromagnetic waves in bounded region,
Get the concept of radiation from the accelerated charge, and
Differentiate among the types of scattering and dispersion in the field of electrodynamics.

Content:

Electromagnetic Field Equation: Maxwell's equations; E.M. energy--Poynting vector; scalar and vector potentials; the wave equations. *Propagation of E.M. Waves*: Plane waves in both conducting and non-conductor media; reflection and refraction at boundaries of two non conducting and conducting media; boundary conditions; total internal reflections. *Propagation of E.M. Waves in Bounded Region*: Propagation between parallel conducting plates; basic principles of rectangular wave guides. *Radiation from an Accelerated Charge:* Dipole radiation, field of charge in uniform motion; fields of an accelerated charge; radiation at low velocities and their application in antenna. *Scattering and Dispersion*: Difference between Scattering and dispersion, types of scattering i.e. Rayleigh, Mie, Thomspn, Brillouin and Raman.

Delivery*:* 30 hours of lectures, 15 hours of tutorials.
Assessment*:* 40% Coursework; 60% final examination.

Textbook
Corson, D.R. and Lorrain, P. Introduction to Electromagnetic Field & Waves. W.H. Freeman and Company. (1990).

References
Popovic, Z and Popovic**, B. D**. Introduction to electromagnetics. Prentice Hall, Upper Saddle River, New Jersey 07458. (2000).
Ulaby, F. T. Fundamentals of applied electromagnetics. Prentice Hall, Upper Saddle River, New Jersey 07458. (199).

PH 319 FUNDAMENTALS OF ATMOSPHERIC PHYSICS 2 UNITS
Objectives*:*
By the end of the course the student should be able to:
Describe and explain the major atmospheric movements and circulations and how they relate to weather;
Explain the physics of cloud formation and precipitation;
Describe weather observation and measurement procedures and weather forecasting models.

Content*:*
Review of atmospheric composition, structure and energy distribution: atmospheric radiative balance; global energy balance and distribution. Atmospheric dynamics: pressure gradients; the Coriolis effect; high and low pressure systems; geostrophic winds; divergence and convergence of air. Atmospheric moisture and lapse rates; the importance of water in the atmosphere; variation of pressure with altitude; dry and moist adiabatic lapse rates; stability of the atmosphere. Cloud formation and precipitation; condensation and cloud formation; cloud types; precipitation. Introduction to Upper level circulation, synoptic scale winds, and air masses; thermal winds, Rossby waves; el Nino Southern Oscillation (ENSO). Weather measurement and forecasting: weather observation and measurement, introduction to weather forecasting: review of forecasting models. Small scale weather systems; cyclones; thunderstorms and lightning.

Delivery*:* 30 hours of lectures, 15 hours of tutorials.
Assessment*:* 40% Coursework; 60% final examination.

Text book*:*
Murray L. Salby, Fundamentals of Atmospheric Physics, Academic Press (ISBN 0126151601), (1996).

References:

Bob Crowder, The Wonders of the Weather, published by Bureau of Meteorology, 2nd edition (2000).
Mason and Hughes, Introduction to Environmental Physics: Planet Earth, life and climate, Taylor and Francis (2001).
Guyot G.C., Physics of the Environment and Climate, Wiley (1998).
Boeker E. and van Grondelle R., Environmental Physics 2nd Ed., John Wiley & Sons (1999).

PH 332 SOLID STATE PHYSICS 2 UNITS

Objectives:

After completing this course, the student will be able to:
Describe simple structures in terms of a lattice and unit cell, calculate the cohesive energy of these structures and understand how they are determined experimentally.
Explain the basic features of the coupled modes of oscillation of atoms in a crystal lattice using the one-dimensional chain as a model and relate crystal properties (specific heat, thermal conductivity) to the behaviour of these oscillations.
Derive the free electron model, show how it explains various metallic properties and identify its strengths and weaknesses.
Explain the effect of the lattice structure on the behaviour of electrons in solids on basis of the nearly-free electron model and the tight-binding model.
Explain the basic features of semiconductors and relate them to simple semiconductor devices.
Explain the magnetic and superconducting properties of materials using simple models of the underlying mechanisms.

Content

Crystal structure, the reciprocal lattice, diffraction in crystals and crystal binding. Lattice dynamics, vibrational modes of a continuous system, elastic waves in an infinite monatomic 1-D and 2-D Lattice. Phonon Statistics and Lattice Specific Heats, Electrons in metals, the Quantized Free Electron Gas, Band theory of solids, dynamics of electron motion and Superconductivity. Semiconductors, transport properties, band shapes in semiconductors.

Delivery*:* 30 hours of lectures, 15 hours of tutorials.
Assessment*:* 40% Coursework; 60% final examination.

Textbook

Kitell C., Introduction to Solid State Physics, 7th Edition, John Wiley & Sons (1996).

Reference

László Mihály and Michael C. Martin. Solid State Physics John Wiley & Sons, (1996) ISBN 0-471 15287-0

PH 334 ENERGY IN THE ENVIRONMENT 2 UNITS

Objectives:

By the end of the course the student should be able to:
Explain the scientific concepts of energy and energy conversion processes;

Describe the world's fossil fuel resources, their depletion, and the environmental impact of their use;
Understand the promise and problems of nuclear energy;
Assess renewable energy sources with emphasis on their strengths and weaknesses for practical energy supply.

Content*:*
Energy Resources and World Energy Use; Analysis of current world energy supplies and Tanzania energy consumption; Trends in energy consumption; Fossil fuel reserves and related environmental problems; Nuclear Energy; Energy release by fission of uranium and plutonium. Advantages and disadvantages of nuclear fission for power production; The operation of a nuclear fission reactor; Nuclear waste and radiation hazards; Renewable Energy Resources; The sun as the earth's major source of renewable energy; Solar radiation: Active and passive solar heating; Solar thermal electric power generation; Photovoltaic conversion of solar to electrical energy; Wind energy and available wind power; Practical wind turbines and wind farms; Hydroelectric power generation and pumped storage schemes; Advantages of hydropower and environmental costs of large dams; Ocean wave energy; Wave energy availability and limitations; Devices for extraction of wave energy; Tidal energy, tidal barrages and tidal streams; Limitations of wind, wave and tidal power; Biomass as a renewable energy source; Importance of energy storage for transport and electricity supply; Hydrogen as a secondary fuel.

Delivery*:* 30 hours of lectures, 15 hours of tutorials.
Assessment: 40% Coursework; 60% final examination.

Textbook*:*
E L McFarland, J L Hunt and J L Campbell - Energy, Physics & the Environment, Wuerz Publishing Ltd., Winnipeg, (1994).

References:
Cunningham W.P. and B. W. Saigo, Environmental Science: A Global Concern, 5th Edition, McGraw-Hill, W.C. Publ. Co.; (1999).
Allaby M. Basics of Environmental Science, Taylor and Francis, ISBN 0-415-21175-1 (UL: 504 ALL) (2000)
Boyle G. Renewwable Energy – Power for a Sustainable Future, OUP/OU, ISBN 0-19-856452-x (UL: 333.82 BOY) (1996).
Twidell J. and Weir T., Renewable Energy Resources, F. and F.N. Spon, ISBN 0-419-12010-6 (UL: 621.4 TWI).

PH 339 ELECTRONICS 3 UNITS
Objectives*:*
By the end of the course the student should be able to:
explain the concepts and terminologies of analogue and digital electronics.
Build simple electronic circuits containing analogue and digital components
Test and trouble-shoot simple circuits by using oscilloscope and multimeter.

Content:
Passive electronic components; Electric circuit laws; Passive filters. Energy bands in solids; Semiconductor theory; Junction diode; Bipolar Junction Transistor, Amplifiers. Transistor switching and applications; Field effect transistor; JFET, MOSFET. Special devices: LDRs,

VDRs, VARICAPs, Thermistors, Opto-electric devices. Transistor building blocks: differential amplifier, current sources/sinks, operational amplifiers. Active filters using operational amplifiers. Oscillators; theory, types, crystal and RC oscillators; function generator. Radio and television transmitters, receivers, modulation and demodulation, antenna, monochrome and colour TV receivers. Binary arithmetic; binary-coded-decimal, ASCII codes and parity. Logic gates; NOT, AND, OR, NAND, NOR, XOR, XNOR Boolean Algebra; logic circuits and Boolean expressions, universality of NAND and NOR gates. Combinational logic circuits; multiplexers, de-multiplexers, half and full adders, encoders and decoders. Sequential logic circuits; latches, flip-flops, D, RS, JK, T flip flops, counters and registers; Pulse circuits; multivibrators, timers and clocks.

Delivery*:* 45 hours of lectures, 15 hours of tutorials.
Assessment*:* 40% coursework; 60% final examination.

Textbook*s*:
Horowitz P and Hill W, The art of electronics. Cambridge University Press (1989).
Comer D. J, Digital logic and state machine design. Saunders College Publisher (1990).

References*:*
Bogart T. F.: Electronics and circuits, Maxwell Macmillan Publishing, (1993)
Mithal G. K. : Electronic devices and circuits. Khanna Publications, Delhi. (2003)
Young P. H,. Electronics communication techniques 4th ED. Prentice-Hall. (1999)
Malvino A. P and Leach D. P,. Digital principles and Applications. McGraw-Hill Publishing Company Ltd. (1998)

PH 346 PHYSICS PROJECT 2 UNITS
Objectives*:*
At the end of the course a student will be able to:
Develop and write a research proposal;
Design and implement a research activity independently;
Use and apply different tools of data analysis;
Write a research report.

Content:
Research methodology; identifying the problem, literature review, sampling, data, collection, analysis and presentation; Independent and supervised research based on topics selected from on-going research activities in Physics or proposed by students provided it is feasible. Emphasis will be on research proposal development, experimental design and scientific report writing.

Delivery: 90 hours of supervised independent research, spread over two semesters.
Assessment: Report (60%), Oral presentation (40%).

Textbook & References;
Non-specific.

PH 351 PHYSICS OF THE ATOMIC 3 UNITS
Objectives*:*
At the end of the course the student should be able to:

Describe the theoretical modeling of atomic structure and its corresponding experimental observations.
Apply quantum mechanical techniques, classical electromagnetism and mechanics as well as optics in order to describe the internal structure of atoms.
Identify and describe the nomenclature for labelling various nuclides.
Describe structure and properties of nuclides.
Explain the theoretical basis for and applicability of the predominant nuclear models.
Describe radioactive decay processes, both natural and induced.
Identify applications of nuclear physics, their limitations and their possible extensions.

Content*:*
Atomic Physics: Rutherford model, Bohr theory, Hydrogen atom: Quantum mechanical description of one-electron atoms, Probability densities and allowed transitions, quantized orbital angular momentum and associated magnetic dipole moments, Stern-Gerlach experiment and the electron spin; magnetic moment, Spin-spin interaction and Hund's rules, spin-orbital interaction and fine structure. Zeeman effect. Two-electron atom: identical half-integer spin particles; the Pauli's exclusion principle; the Periodic Table; L-S and j-j coupling; Optical and X-ray spectra; Molecular bonds **Nuclear Physics**: Nuclear structure and properties: atomic masses, binding energy, and nuclear stability. Nuclear reactions: Cross-sections, the Q-value, and reaction mechanisms. Nuclear models: Strong interaction between nucleons, Liquid drop model and applications to fission and isobaric transformations; Shell model and prediction of selected nuclear properties. Natural and artificial radioactivity: Conservation laws for radioactive decay and nuclear particle energies; The Mössbauer effect. Nuclear energy: Breeder reactors; fusion and fusion as energy sources; the atomic bomb; the hydrogen bomb.

Delivery*:* 45 hours of lectures, 15 hours of tutorials.
Assessment*:* 40% Coursework; 60% final examination.

Text Books
1. Beiser A., Concepts of Modern Physics, 6th Edition, McGraw-Hill, (1995).
2. K.S. Krane, Introductory Nuclear Physics, Wiley. (1988).

References:
Haken H. and Wolf H.C., Physics of Atoms and Quanta, Springer, 6th Ed.,(2000).
Basdevant J.L. and J. Dalibard, Quantum mechanics Solver: How to Apply Quantum Theory to Modern Physics. Springer-Verlag, Berlin, (2000).
Eisberg R. and R. Resnick, Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles 2nd Edition, John Wiley, (1985).
Griffiths D. J. , Introduction to Elementary Particles. Wiley, N; (1987).
Chen F.F., Introduction to Plasma Physics, 2nd Edition, Plenum Press, (1984).
John S. Lilly, Nuclear Physics, First Edition, John Wiley, (2001).

PH 359 ASTROPHYSICS 2 UNITS
Objectives:
By the end of the course the student should be able to:
Describe the vast processes in the universe.
Apply the tools of astronomy to understand the nature of stars, planetary motion, galaxies and the universe.

Content

The Tools of Astronomy: The Celestial Sphere, Celestial Mechanics, the Continuous Spectrum of Light, General relativity: the Interaction of Light and Matter, Telescopes. The Nature of Stars**:** Binary Systems and Stellar Parameters, the Classification of Stellar Spectra, Stellar Atmospheres, the Interiors of Stars, the Sun, the Process of Star Formation, Post-Main-Sequence Stellar Evolution, Stellar Pulsation. Supernovae, the Degenerate Remnants of Stars, Black Holes, Close Binary Star Systems. Planetary Systems: Physical Processes in the Solar System, the Terrestrial Planets, the Jovian Worlds, Minor Bodies of the Solar System, the Formation of Planetary Systems. Galaxies and the Universe**:** The Milky Way Galaxy, the Nature of Galaxies, Galactic Evolution, the Structure of the Universe, Active Galaxies, Cosmology, the Early Universe.

Delivery: 30 hours of lectures and 15 hours of Tutorials.
Assessment: Coursework, 40%, final examination 60%.

Textbook:
Bradley, W. Caroll, Dale, Ostilie :An Introduction to Modern Astrophysics, Addison-Wesley, (1996).

References:
Berry M.: Principles of Relativity and Cosmology, Cambridge Press, (1976).
S.Dodelson: Modern cosmology, Academic Press, (2003).
Greene, Brian. The Elegant Universe. W. W. Norton & Company, (1999).

PH 364 THE EARTH-ATMOSPHERE SYSTEM 2 UNITS

Objectives*:*
At the end of the course the students should be able to:
Explain the evolution of the universe;
Describe and explain the relation and importance of the solid earth, oceans and the atmosphere;
Explain the structure and processes in the earth's interior and in the oceans;
Explain the origin and behaviour of the earth's magnetic field.

Content*:*
Brief review of the evolution of the universe: The earth's atmosphere: structure, composition and temperature distribution. The ozone layer, greenhouse effect, global warming and climate change. The oceans: movements, tides and waves. The solid earth: evolution, structure, composition and temperature distribution. Volcanoes: origin, types and consequences. Earthquakes: origin, types, and magnitude; the Richter scale; consequences and precautions. Seismic waves: S, P, and L waves: properties, detection and measurement. Prediction of earthquakes. The earth's magnetic field: existence, origin and position; effect of the Allen-Belt atmospheric current; short and long term variations; Measurement: components, angle of dip and declination; applications.

Delivery*:* 30 hours of lectures, 15 hours of tutorials
Assessment*:* 40% coursework; 60% final examination.

Textbooks*:*
William Lowrie, Fundamentals of Geophysics, Cambridge University Press, (1997).
Boeker E. and van Grondelle R., Environmental Physics 2nd Ed., Wiley & Sons (1999).

References:
Mason N.J.and Hughes P., Introduction to Environmental Physics: Planet Earth, life and climate, Taylor and Francis (2001).
Guyot G. C., Physics of the Environmental and Climate Wiley & Sons (1998).
Monteith J.L. and M. Unsworth, Principles of Environmental Physics, Second Edition, Edward Arnold, (1990).

PH 370 PHYSICS PRACTICAL TRAINING 2 UNITS

Objectives:
By the end of the course students should able to:
To combine theory learned in class and skills and experience gained during practical training to solve practical issues in applied physics.
Experience and practice the corresponding area of specialization in the actual field.
Write scientific report related to activities of the host institution.

Content:
This is a field based course. The students will be integrated into the daily routines of the host institution. Emphasis will be on those activities related to physics aspects to acquaint the students with necessary working experiences.

Delivery: 8 weeks of institutional attachment.
Assessment: Employer's report 10%, logbook 30%, Final report 50%, presentation 10%.

PH373 THE BASICS OF NMR SPECTROSCOPY 2 UNITS
Objectives:
At the end of the course a student will be able to
Explain the basic concepts and theory of NMR spectroscopy.
Understand the power of the NMR for structure elucidation and as a tool for predicting organic molecular structure.

Content
Spin Physics: Spin, properties of spin, energy levels, NMR transitions, continuous wave NMR experiment, Boltzmann statistics, spin packets, T1 process, precision, T2 processes, rotation frame of reference, pulsed magnetic fields, spin relaxation, spin exchange, Bloch equations; **NMR Spectroscopy**: Chemical shift, spin-spin coupling, time domain NMR signal, +/-frequency conversion; **Fourier Transforms:** The +and – frequency problem, Fourier transforms, phase correction, Fourier pairs, the digital FT, sampling error, the 2D FT; **Pulse Sequence**: 90-FID, spin-echo, inversion recovery, **Practical considerations**: sample preparation, exchange, probe tuning, determining a 90^o pulse, field shimming, phase cycling, 1-D hydrogen spectra, integration SNR improvement, variable temperature, troubleshooting, cryogen fills, Unix primer; Carbon-13 NMR: Decoupling, population inversion, NOE, 1-D spectra.

Delivery: 30 hours of lectures, 15 hours of tutorials.
Assessment: 40% coursework; 60% final examination.

Textbooks:
Keeler J, Understanding NMR Spectroscopy , Wiley Inter science (2002)
Lambert JB and Mazzola EP; Nuclear Magnetic Resonance Spectroscopy: An Introduction to Principles, Applications, and Experimental Methods; Prentice Hall (2003).

Reference

Gunther H, NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry Willey Blackwell (1995) 2nd Edition.