SCHOOL OF APPLIED PHYSICS

Head of Department

David Kolkoma, PhD (PNGUoT,PNG), MSc (QUT, Australia), B.Eng (PNGUoT),PG Cert(USC, Australia) and PG Dip(PNGUoT)

Reseacrh Area: Medical Physics, Radiation Physics

Applied Physics Section

Academic Team

Professors

Mukhopadhyay, Manoj, Ph.D. (Indian School of Mines, Dhanbad, India); M.Sc. (Applied Geophysics) (ISM); B.Sc. (Hons.) (Applied Geophysics) (ISM)
Research Area: Applied Geophysics: Geophysical Modeling, Earthquake Seismology, Crustal Geophysics

Jojo Panakal John M Phil & Ph D (Aligarh Muslim University, Aligarh, India) M Sc & B Sc (Mahatma Gandhi University, Kottayam, India).

Research Area: Nuclear and Radiation Physics, Environmental Physics

Associate Professors

Pereira, Felix Ph.D, M.Phil, M.Sc B.Sc (Kerala, India)
Research Area: Astrophysics, Atmospheric physics, Radiation physics and Electronics.

Dapsy Olatona, PhD (UNSW, Aus), MSc (OAU), BSc (UNICAL).

Research Area: Energy and spectroscopy

Senthilkumar, V. PhD (Gandhigram Rural Uni, India), MSc and BSc (Bharathiar Uni, India)

Research Area: Energy nanomaterials, 2-D materials, Solar cells and Oxide resistive memories

Senior Lecturers

Anduwan, G.A. EdD and M.Sc (Ball State-USA), B.Eng(PNGUoT), Dip CERT(PNGUoT)

Research Area: Energy applications, Geophysics, Nanotechnology, Environmental Physics, Physics Education, Condense Matter and other applications of Physics using Microcontrollers and Electronics.

Kolkoma, D. PhD(PNGUoT),Msc(QUT, Aust), B.Eng (PNGUoT), PG Cert(USC, Australai) and PG Dip (PNGUoT).

Reseacrch Area: Medical Physics, Radiation Physics

Ali Mohammed PhD(IID India), Msc(IIT India)

Research Area: Applied Geophysics in Oil, Gas, and minerals

Lecturers
Ampana S. MSc (Nagoya Univ. Japan), BSc (PNGUoT)

Research Area: Applied Geophysics and Non-Destructive Test (NDT)

Waimbo Mathew. MSc(PNGUoT), BSc(PNGUoT)

Research Area: Nanotechnology, Condense Matter and Electronics.

Gaoma, Michael. MEd(Charles-Stuart-Aus), BSc(UPNG)

Research Area: Physics Education

Tonny Kenson, MSc (PNGUoT), BSc(PNGUoT)

Research Area: Microcontroller based projects, Smart Hybrid Renewable Energy Systems, Data Acquisitions and smart monitoring mechanisms for Renewable Energy Systems and Aircraft Tracking Systems in PNG.

Sylvester Tirones, MSc (PNGUoT), BSc(PNGUoT

Research Area: Electonics, Microcontrollers and Microprocessor applications.

Gideon Aiyowa, Msc(PNGUoT), BSc(UPNG)

Research Area: Geology, Applied Geophysics

Biomedical Engineering Section

Academic Team

Professors
Dr. Dhyaa Kafagy, PhD, PE, CSWP

Biomedical Engineering Professor (Online Lecturer)

Associate Professors
Kamran Hassani (Online lecturer)
Saravana Kumar Jaganathan (Online lecturer)

Technical Team

Chief Technical Officer
Kenny Michael, BSc (UNITECH)

Senior Technical Officers

William Piel, BSc (Unitech)

Technical Officers

Geoffrey Wiavi, BSc(UNITECH)
Simeon Ifu BSc (UNITECH)
Israel Dujambi BSc(UPNG)

<u>Administration Team</u>

Senior Secretary

Sulunga Benjamin, Sec Certificate(POM Business College)

Secretary

Shalom Tera Sec Certificate(Bulolo Tech

Janitor
Nickson Piwi Gr 10 Certificate

Degree Programs

The School of Applied Physics with Electronics and Instrumentation consists of two sections, Applied Physics with Electronics and Instrumentation and Biomedical Engineering. The School also offer Service Courses to other Academic Departments. The four-year academic programs leading towards:

(a) Bachelor of Science in Applied Physics with Electronics and Instrumentation
(b) Bachelor of Engineering in Biomedical Engineering

These degree programs are designed to produce Applied Physics graduates who are employability in almost all areas including, manufacturing, mining and gas exploration, telecommunications, Energy generation, Information technology, airline industries, Security force, government departments, universities, Health Care, Banks and NGO groups. Biomedical Engineering graduates are concerned with life saving equipment to sustain health care offered by the country's National Health Department and privately run health care facilitates.

The first year of each course is designed to form a common foundation upon which years 2, 3 and 4 of the separate professional choice based on their selection at Gr 12 entry requirements.

The minimum entry requirements for both Bachelor of Science in Applied Physics with Electronics and Instrumentation and Biomedical Engineering is B grades in Physics, Advanced Mathematics, Chemistry or Biology and a C Grade in Language and Literature.

Entry requirements (any one of the following):

i) Applied Physics with Electronics and Instrumentation**:** Grade 12 School Leavers: STAT_P Test Score, Minimum of B grades in physics, Maths A , chemistry and C grades in either Language and Literature or Applied English.
ii) Biomedical Engineering: Grade 12 School Leavers: STAT_P Test Score, Minimum of B grades in chemistry or Biology, Maths A , physics and C grades in either Language and Literature or Applied English.
iii) All non school leavers entering into Applied Physics nad Biomedical Engineering programs: as in school leaver requirements except that upon acceptance with the minimum requirement will do entry exams instead of STAT-P test.
iii) Diploma Certificate from Polytechnical Institute with Credit grades in science related subjects are invited to do entry exams before entry.
iv) Diploma from outer universities will be selected on case by case basis.

Physics is taught to students from Agriculture, Forestry and Applied Science departments. Physics is also offered in the summer session as a component of the University's Adult Matriculation program.

The Department also offers postgraduate degrees in Master of Applied Physics (MSc) by course work, Master of Philosophy (MPhil) and Doctor of Philosophy (PhD) by research.

Entry requirement for a MSc and MPhil is Bachelors Degree in Science with above average grades from a recognized university and for a PhD program Master of Science degree is required.

COURSE STRUCTURE

BACHELOR OF SCIENCE IN APPLIED PHYSICS WITH ELECTRONICS AND INSTRUMENTATION

First Year First Semester

Code	Subject	Contact Hours	Credit
AP111	Introductory Physics I	6	17
AS111	Foundation Chemistry	6	15
EN112	Engineering Mathematics I	6	22
CD112:	English Grammar & Composition I	6	15
		24	**69**
First Year	**Second Semester**		
AP121:	Introductory Physics II	6	17
AS112:	Introduction to Applied Chemistry	6	15
EN121:	Engineering Mathematics II	6	22
CD126:	English Grammar & Composition II	6	15
		24	**69**

Second Year First Semester

Code	Subject	Contact Hours	Credit
EN212:	Engineering Mathematics III	6	22
AP211:	Circuit Theory	6	18
CS214:	Introduction to Programming	6	19
AP212:	Classical Mechanics	6	18
		24	**77**
Second Year	**Second Semester**		
AP221:	Thermodynamics and Cryogenics	6	18
AP222:	Digital Signal Processing	6	18
AP223:	Physics of Materials	6	18
EE221:	Digital Logic System	6	17
		24	**71**

Third Year First Semester

Code	Subject	Contact Hours	Credit
EE341:	Computer Architecture	6	21
AP311:	Quantum Physics	6	18
AP312:	Instrumentation	6	18
AP313:	Programmable Devices	6	18
		24	**75**
Third Year	**Second Semester**		
AP321:	Electromagnetic fields &Waves	6	18
AP322:	Solid State Physics	6	18
AP323:	Physical Electronics	6	18
AP324:	Physics of Non-destructive Testing	6	18
		24	**72**

Fourth Year First Semester

Code	Subject	Contact Hours	Credit
AP412:	Modern Optics & Lasers	6	18
AP413:	Radiation Physics	6	18
AP414:	Exploration Geophysics I	6	18
EE411:	Control Systems	6	21
***AP411:**	**Project I**	**6**	**8**
		30	**83**
Fourth Year	**Second Semester**		
AP424:	Energy Sources	6	18
AP425:	Exploration Geophysics II	6	18
AP426:	Physics of Environment	6	18
EE421:	Instrumentation and Process Control	6	21
*AP412	Project II	**6**	**8**
*AP422	Industrial Training		**8**
		30	**91**

*AP 411 is a final year project which the students should undertake immediately, however will not be assesses until the the second semester as AP 412 Project II.

*AP 422: Industrial Training -Work integrated Learning starts in Year 2 of the program around November to January during Christmas breaks.

*The Assessment Tasks is as generally listed below and may vary from course to course according to the course lecturer's delivery plan, however the final mark is 100%. Most courses are 50% continuous and 50% external examination.

AT1 - Lab reports: Report/s for practical sessions will weigh 10% of the total marks.

AT2 – Class tests: There will be 3 class tests weighing 25%

AT3 – Assignments: There will be 3 assignments weighing 15%

AT4 - Final written examination: A 3 hour written examination weighing 50%

The School of Applied Physics Graduate will identify, research, formulate, design, built test systems for physical problems and ensure sustainability.They will be future focus in innovative and entrepreneurial in creating wealth using available resources. The Graduates will easily integrate into any working environment.

COURSE LEARNING OUTCOMES (CLOs)

1	Ability to identify, analyse, formulate , simulate, design and/or build and test systems for physical problems.
2	Ability to describe, explain, and communicate effectively to others, as well as ability to prepare formal technical plans and reports detailing solutions of problems in physical systems.
3	Ability to understand and recognize the need for, to engage in life-long learning to continuously upgrade their knowledge to a higher learning via research activities, personal readings and by attending short seminars and workshops from time to time.
4	Ability to work on multidisciplinary teams and understand the scope of work and issues that allow the team to achieve their goal.
5	Ability to apply the knowledge of mathematics and Physics and science in general, in all aspects related to physical systems.
6	Ability to design and conduct experiments, as well as to analyse and interpret data collected.
7	Ability to conduct and manage projects in multidisciplinary environments and apply appropriate techniques and skills, as well as project management concepts and tools necessary to complete those projects with success.
8	Broad knowledge and understanding of contemporary issues due to the changing of global economy, environmental impact of those changes, and the social context involved.
9	Develop an understanding of professional, safety and ethical responsibility at all times.
10	Ability to conduct experiments or lead researches especially in academia and analyze data to come up with useful conclusions and recommendations in relation to improve the academic environment in teaching and learning.

AP111: Introductory Physics I

Hours per week: 6 (3 Hr Lectures /1 Hr Tutorial /2 Hr Lab)
Credits: 17

Pre-requisite: Grade 12

Learning Outcomes:
On completion of this subject the student should be able to:-

LO1. Explain the basic fundamental units.

LO2. Analyse and solve simple problems in kinematics.

LO3. Evaluate the equations of force and motions

LO4. Analyses different types of waves.

LO5. Calculate equations involving properties of matter.

LO6. Develop skills in team work to solve equations of fluids and dynamics.

LO7. Analyse and solve equations involving gas and matter expansions and the cooling processes.

Syllabus:

Fundamental Units of Scalars, Vectors and Quantities: Units of measurements, physical quantities, dimensional analysis, scalar and vector quantities. and units, significant figure, errors in measurements.

Kinematics: Concepts of motion, velocity and acceleration as vectors. Motion in one and two dimensions; projectile motion and circular motion.

Force and Motion: Dynamics of a particle. Concepts of mass, force, impulse and momentum. Rotational motion of a rigid body; moments of inertia, angular momentum, torque.

Oscillations and Waves: Simple Harmonic Motion (SHM). The kinetics and dynamics of SHM. Energy in SHM. Application to spring problems and the pendulum. Damped and forced oscillations. Classification of wave motion. Travelling waves, Superposition of waves, equation of a progressive wave, wave length and phase difference. Beats: the phenomenon of beats.

Stationary(standing) waves: the formation and properties of stationary waves. Velocity of sound in gases: Newton's formula, Laplace correction. The Doppler effect: derivation of expression for freqency change, the Doppler effect with light.

Properties of matter: Elasticity, Stress, strain, moduli of elasticity, Poisson's ratio. Surface tension, Excess of pressure inside curved surfaces.

Fluid Dynamics: Basics concepts of ideal flow, Continuity equation, Bernoulli and momentum equations, Streamline flow and turbulent flow, Reynold's number, Viscosity.

Thermometry and calorimetry: temperature scales, heat capacity, measuring specific heat capacities, latent heat. Gases: the gas laws, ideal gas equation, the kinetic theory of gases. Avogadro's law, external work done by an expanding gas, isothermal processes, adiabatic processes. Heat transfer: thermal conduction, definition of thermal conductivity, thermal radiation, the concept of black body, convection. Stefan's law, Newton's law of cooling.

Textbook:

Young, H.D. University Physics, 8th Edition (Addison-Wesley, 1992).

Assessment:

Continuous Assessment - **50%**
Written Examination - **50% (1x3 hrs)**

AP 121: Introductory Physics II

Hours per week: 6 (3 Hr Lectures /1 Hr Tutorial /2 Hr Lab)
Credits: 17

Pre-requisite: AP 111

Learning Outcomes:

On completion of this subject the student should be able to:-

LO1. Apply the concepts of electrostatics to simple point and continuous charge distributions.
LO2. DC and AC Circuits, current and voltage laws RLC Circuits, .

LO3. Apply the laws of electromagnetism to simple problems.

LO4. Discuss Geometrical Optics concepts related to lenses, mirrors, and basic optical instruments.

LO5. Describe and solve problems related to waves concepts applied to electromagnetic waves.

LO6. Discuss the wave properties of light.

Syllabus:

Electrostatics: Concepts of charge and electric field. Coulomb's law. Gauss' law. Calculations of electric field for discrete and continuous charge distributions. Electrostatic potential.
Capacitance and Current electricity: Ohm's law. Electromotive forces, DC and AC circuits, Kirchhoff's rules, RLC Circuits and their applications to power transmission.
Magnetism: Magnetic force on current-carrying conductors, the electric motor. Magnetic field due to a current, the Biot-Savart law. Force between currents, the Ampere. Laws of electromagnetic induction. Application to the dynamo, eddy currents. Self-inductance, energy stored in an inductor.
Geometrical Optics: Refraction: laws of refraction. Lenses and mirrors: basic properties, images, determination of focal length, lenses and mirrors formula, etc.
Electromagnetic waves: electromagnetic spectrum.
Wave properties of light. Wave front. Interference of light waves. Young's double-slit experiment. Diffraction of light waves, diffraction at a single slit, diffraction produced by multiple slits. Polarization of light waves.
X-rays: Production, Bragg's law. Atomic spectra, Nucleus, Radioactivity, Nuclear fission, fusion.

Textbook:
Young, H.D. University Physics, 8th Edition (Addison-Wesley, 1992).

Assessment:
Continuous Assessment **- 50%**
Written Examination **- 50% (1x3 hrs)**

AP 211: CIRCUIT THEORY

Hours per week: 6 (3 lectures/2Tut/1 lab)
Credits: 18, Core

Prerequisites: AP121, EN121

Learning Outcomes:
On completion of this subject the student should be able to:-

LO1. Define and explain basic circuit elements.

LO2. Describe and analyse each type of circuits and its basic theories.

LO3. Apply appropriate methods for calculation in solving different types of circuits.

LO4. Evaluate each laws and theorems such as Ohm's law, Kirchhoff's law, mesh and nodal analysis, Thevenin's and Norton's theorems and other methods of solving problems.

LO5. Apply the theorems in both series and parallel circuits using ac and dc circuits in Ohmic, inductive and capacitive circuits.

LO6. Explain different time constants and waveforms, resonance circuits and filter circuits with its response curve.

Syllabus:
Electrical conduction in metals, resistance, ohms laws, Kirchhoff's rules, Application to series and parallel circuits.
Transients in RC circuits, Response to d.c. voltages, Time constants, Applications to time base and pulse shaping, Measurement of high resistance by capacitor leakage
Mesh and Nodal Analysis of d.c. circuits, Analysis of circuits with current sources and resistors, Thevenin's theorem; Norton's theorem; Millman's theorem. voltage across the resistor, capacitor and inductor, Active and passive elements. Vector Impedance diagrams.
Complex number representation, Power in a.c. circuits, The resonance condition, Nodal and mesh analysis for a.c. circuits.

Textbook:
Bernard Grob, Mitchel E. Schultz , Basic Electronics, 9th edition, (McGraw-Hill, 2003).

Assessment:
Continuous Assessment **- 50%**
Written examination **- 50% (1 x 3 hrs)**

AP 212: CLASSICAL MECHANICS

Hours per week: 6 (3 Hrs Lecture/2 Hr Tut/1 Hr Lab) Credits: 18

Prerequisite: AP 131, AP132

Learning Objectives:
On completion of this subject the student should be able to:-

LO1: Describe how a particle moves in a given situation in the simplest manner;

LO2: Explain the motion of a particle with reference to a coordinate system which itself is moving;

LO3: Define central force and discuss celestial mechanics; LO4: Discuss the motion of a system of a particle;

LO5: Discuss the action principle for classical fields;

LO6: Discuss the application of Lagrangian and Hamiltonian formalisms to describe the motion of a rigid body.

Syllabus:
Kinematics and particle dynamics. Conservation theorems.

Translation of coordinate systems. Inertial and on-inertial reference systems. Rotation of coordinate system. Effects of Earth's rotation. Coriolis force and centrifugal force. The Foucault pendulum. Gravitation and central forces. Gravitational potential. Motion in an inverse-square repulsive force field. Equations of motion, potential energy and differential equations describing the motion of a particle in a central force field.

Motion of two interacting bodies. The reduced mass. Collisions. The laboratory and centre of mass coordinate systems. Impulsive force. Motion of a body of variable mass. Rocket motion.

Rotation of a rigid body about a fixed axis. Moment of inertia. The physical pendulum. General theorem concerning angular momentum.

Rotation of a rigid body about an arbitrary axis. Principal moments and product of inertia. Rotational kinetic energy of a rigid body. Principal axes and their directions. Motion of a rigid body under no torques. Free rotation of a rigid body with an axis of symmetry. Special Theory of relativity.

Generalised coordinates. Degrees of freedom. Constraints. D'Alembert's principle. Lagrange's equations. Calculus of variations.

Textbooks:
1. Fowles, G.R., Analytical Mechanics, (Holt, Rinehart and Wilson, latest edition).
2. Goldstein, H., Poole, C. & Safko, J., Classical Mechanics (Addison Wesley, latest edition).

Assessment:

Continuous Assessment	**- 50%**
Written Examination	**- 50% (1 x 3 hrs)**

AP 221: THERMODYNAMICS AND CRYOGENICS
Hours per week: 6 (3 Hrs Lecture/2 Hr Tut/1 Hr Lab)
Credits: 18

Prerequisite: AP132, MA168

Learning Objectives:

On completion of this subject the student should be able to:-
LO1. Define concepts of thermodynamics such as isolated, closed and open system, thermodynamic equilibrium, quasi-static and non-quasi-static process, etc;
LO2. State the laws of thermodynamics and discus some of the consequences of the first and second laws of thermodynamics;
LO3. Thermodynamics refrigerant properties.
LO4. Principles of air conditioning. The heat pump.
LO5. Cryogenic systems. Cryogenic Electrical and Electronic control circuitry

LO6. Cryogenic instrumentation and equipment selection.

Syllabus:
Scope of Thermodynamics, thermodynamic System, thermal equilibrium
Laws of thermodynamics, Consequences, Equation of state of an ideal and real gas. Internal Energy, Enthalpy, Heat capacity, Entropy,
Temperature-Entropy Diagram. The Principle of increase of entropy, third law of thermodynamics.
Thermodynamics refrigerant properties.
Principles of air conditioning. The heat pump. Cryogenic systems. Cryogenic instrumentation and equipment selection

Textbook:
1. Sears, F.W. and Salinger, G.L., Thermodynamics, Kinetic Theory and Statistical Thermodynamics, 3rd edition (Addison-Wesley, 1975).

Reference:
1. Zemansky, M.W. and Dittman, R.H., Heat and Thermodynamics, 6th edition (McGraw-Hill, 1981).
2. Mandl, F. 1988, Statistical Physics, 2nd edition, Wiley. Finn, C.B.P., 1993. Thermal Physics, Chapmann and Hall.

Assessment:
Continuous Assessment **- 50%**
Written Examination **- 50% (1 x 3 hrs)**

AP 311: QUANTUM PHYSICS

Hours per week: 6 (3 Hrs Lect/2 Hr Tut/1 Hr Lab) Credits: 18

Learning Objectives:
On completion of this subject the student should be able to:-

LO1. Explain basics of emergence of quantum mechanics.
LO2. Describe the wave function, uncertainty principle and Schrodinger equation.
LO3. Apply the theory in solving problems like particle in a box, harmonic oscillator and tunneling.
LO4. Explain the solution of Schrodinger equation.
LO5. Describe the eigen values, eigen functions and eigen equations.
LO6. Explain the fine structure spectrum of hydrogen atom.

Syllabus:
The Emergence of Quantum Mechanics - Black body radiation, photoelectric effect, Compton effect, wave particle duality, Davisson and Germer experiment, Rutherford alpha scattering experiment, The Bohr atom, Bohr postulates, Correspondence principle, quantum numbers, Vector atom model
Postulates of quantum mechanics, The Wave Function, statistical interpretation, probability, normalization, momentum, uncertainty principle, Schrödinger equation, time independent Schrödinger Equation.
Simple applications of Schrödinger equation - free particle solutions – step potential – barrier potential- potential well of finite depth - infinite well - harmonic oscillator - quantum mechanical tunnelling.

Hydrogen atom (one electron system) – concept of reduced mass - development of Schrödinger equation – separation of time independent equation – solution of equation – Eigen values – quantum numbers – degeneracy – Eigen functions – probability density – angular momentum – Eigen equations.
Stern-Gerlach experiment, Spin angular momentum, Pauli Exclusion Principle, Atomic spectra

Textbooks:
Eisberg, R. and Resnick, R, Quantum Physics (Wiley).
Serway, Moses and Moyer, Modern Physics, 3rd ed. Thomson/Brooks Cole.

Assessment:
Continuous Assessment **- 50%**
Written Examination **- 50% (1 x 3 hrs)**

AP313: PROGRAMMABLE DEVICES

Hours per week: 6 (3 Hrs Lect/2 Hr Tut/1 Lab) Credits: 18,
Prerequisite: EE221

Learning Objectives:
On completion of this subject the student should be able to:-

LO1. Explain and review the digital logic systems.
LO2. Describe the electronic components of semiconductor devices
LO3. Explain the different integrated circuits and their operations.
LO4. Apply the fundamental theory of input/output interface modules and the assembly language.
LO5. Describe the theory of microprocessors and microcontrollers and its operation.
LO6. Explain how the microcontrollers receive instructions to perform its operation.

Syllabus:
Review of digital logics, Semiconductor diodes, BJT, FET, MOSFET, Digital circuit and combinational logic, Sequential logic and flip-flops, ADC & DAC, Data acquisition systems, Memory systems, Case studies of electronic systems like microprocessors.

Integrated circuits, TTL and MOS logic circuits, Gating Networks Logic design: Flip – Flops Transfer circuits, Clocks, shift registers, Counters, State diagrams and State tables, Magnitude comparator, Programmable Arrays of Logic cells. Elements of ALU Design and implementation of Binary Address (Half and Full) and Subtractors, BCD Adder, Multiplexer, encoder, decoder, Floating point number systems, Arithmetic operations with Floating point numbers. Input – output interface modules, I / O versus memory bus, isolated versus memory, mapped I / O, asynchronous data transfer, direct memory access (DMA), input-output processor (IOP): CPU, IOP communication, memory organization. Microcomputers, microprocessor and assembly language, microprocessor architecture and microcomputer systems: microprocessor architecture and its operations, memory, input and output, 8085 MPL, 8085 based microcomputer, memory interfacing. The 8085 programming model, addressing techniques, 8085 instruction, code conversion, BCD arithmetic operations. Microcontrollers-8051, Microcontroller-architecture-special function registers, addressing modes, instruction set.
Origin of PIC Micro:- Introduction to PIC micro-Architecture and hardware, block diagram, working registers, program memory, data memory, file registers, program concepts of status register, stack file selection register, option register, indirect data addressing register, digital I/O port, clock oscillators, timer modules, pre-scalar, watch dog timer, reset circuitry, instruction cycle, long word instruction, power down mode sleep, configuration fuses
Instruction set and program development:- Instruction set types, MPASM, source code formats, labels, mnemonics, operands, comments, files with default extension, lists file format, error file format (EPR), operators , procedure , text strings, numeric constants and radix key to PIC 16/17 form instruction sets.

Textbooks:

1. Mathur, A. P., Introduction to Microprocessor, T.M.H. 1990.
2. Bartee, T. C.,Digital Computer Fundamentals,, T.M.H. 6th edition 1991.
3. Ramesh, A., &Goankar, S.,.Microprocessor Architecture, Programming and Applications with the 8085/8080 Wiley Eastern Ltd.
4. Salivahanan, S., Vallavaraj, A. & and Gnanapriya,C., Digital Signal processing, Tata McGraw Hill
5. Embedded control hand book, volume 1995/96
6. PIC 16/17 microcontroller data book, volume 1996/1997

References:

1. Hall, D. V., Microprocessors and interfacing – Programming and Hardware, TMH, 1997.
2. Mano, M. M., Computer System Architecture, 3rd ed., PHI.

Assessment:
Continuous Assessment **- 50%**
Written Examination **- 50% (1x3 hrs)**

AP 321: ELECTROMAGNETIC FIELDS & WAVES

Hours per week: 6 (3 Hrs Lect/2 Hr Tut/1 Hr Lab) Credits: 18
Prerequisite: AP 211

Learning Objectives:
On completion of this subject the student should be able to:-

LO1. Demonstrate familiarity with the physical concepts relating to electric and magnetic fields in free space and in materials
LO2. Calculate the strengths of electric and magnetic fields and their potentials in a variety of systems.
LO3. Apply appropriate methods for calculation in solving different types of circuits.
LO4. Demonstrate familiarity with the physical concepts relating to time varying electric and magnetic waves in free space, non-conducting and conducting medium.
LO5. Calculate the strengths of electric and magnetic waves and their potentials in a variety of systems.
LO6. Define and explain basic working principles of dipole antennas and antenna arrays.

Syllabus:
The electric field and electrostatic potential. Gauss's law and divergence. Deductions from Gauss's law.
Laplace's and Poisson's equations. Equipotentials and lines of force. Electric dipoles and quadruples. Dielectrics.
Polarization, displacement, boundary conditions for displacement and electric field. Energy in a field with dielectrics.
Magnetic field of a current: Ampere's Law, Electromagnetic induction, Faraday's laws, Lenz's law.
Maxwell's equations in differential and integral forms. Electric waves in non-conducting media. Vector and scalar potentials.
Energy flow in plane waves, Pointing vector. Reflection and refraction for non-conducting media, polarisation. Electric waves in conducting media. Reflection at a metallic surface, skin effect.
Application to the hollow rectangular waveguide. TE modes. Signal and group velocities. The single half-wavelength antenna. Brief treatment of antenna arrays.

Textbook:
1. Grant, I.S. and Phillips, W.R., Electromagnetism, ELBS edition (John Wiley, 1978)

Reference:
1. Lorrain, P., Carson, D.P. and Lorrain, F., Electromagnetic Fields and Waves, 3rd edition (W.H. Freeman, 1988).

Assessment:
Continuous Assessment **- 50%**
Written Examination **- 50% (1x3hrs)**

AP 322: SOLID STATE PHYSICS

Hours per week: 6 (3 Hrs Lect/2 Hr Tut/1 Lab) Credits: 18, core

Prerequisite: AP 262
Learning Objectives:
On completion of this subject the student should be able to:-

LO1. Describe the bonding structure and basic structure of crystals.

LO2. Describe the phonon vibrations and quantization of elastic waves.
LO3. Explain the thermal properties of phonons. **LO4.** Study the band theory of solids.
LO5. Study the superconducting property of the materials, elements of BCS theory and Josephson effect.
LO6. Describe the theory of Diamagnetism, Para magnetism and Ferromagnetism.

Syllabus:

Review of questions on the properties of solids, bonding types and crystal structures, crystals of inert gases, London interaction, Ionic crystals, covalent crystals and elastic constants.

Crystal vibrations, Phonons, first Brillouin zones, force constants, quantization of elastic waves, thermal properties of phonons, heat capacity-Debye * Einstein models of density of states.

Band theory of solids, free electron model, Fermi level, density of electronic state, kinetic energy of free electron gas at 0K, quantum theory of electrical conductivity.

Super-conductivity, review of experimental results, influence of magnetic fields, the meissner effect, type I and II superconductors, the superconducting gap, isotope effect, elements of BCS theory, tunneling, a.c. and d.c. Josephson effects, introduction to ceramic superconductors.
Quantum theory of diamagnetism and paramagnetism, spectroscopic g factor, susceptibity, Ferromagnetism, Curie temperature and exchange integral, temperature dependence of saturation Magnetization, Magnons, Neutron magnetic scattering, Antiferromagnetism, Ferrimagnetism, Ferromagnetic domains-Origin of Domains, Coercive force and Hysteresis.

Textbook:

1. Kittel. C., Introductory to Solid State Physics, 8th edition (John Wiley, 2005)

Assessment:
Continuous Assessment **- 50%**
Written Examination **- 50% (1 x 3hrs)**

AP 323: PHYSICAL ELECTRONICS

Hours per week: 6 (3 Hrs Lect/2 Hr Tut/1 Lab)
Credits: 18,
Prerequisite: AP 262

Learning Objectives:
On completion of this subject the student should be able to:-
LO1. Explain basics of semiconductor
LO2. Describe the Femi level in semiconductors.
LO3. Explain the different diode connections and their applications.
LO4. Apply the fundamental theory of transistors in different types of circuits.
LO5. Describe the theory of operational amplifiers and explain different circuits using OP APMs.
LO6. Explain the functioning of different types of special devices.

Syllabus:
Basic idea of Quantum Physics and electrons in solids that is relevant to the physics of semiconductors. Energy of electrons in orbit. Classification of materials as conductors, semiconductors and insulators. Crystal structure of common semiconductors, Energy band model of semiconductors, Effective mass, hole concept, density of state function.
Basic ideas of electron statistics, Fermi level and Fermi function, Intrinsic and extrinsic semiconductors, Calculation of electron and hole densities and Fermi level in each case. Charge transport, drift, diffusion, and mobility. Formation of a barrier, contact potential, space charge region, biasing of a junction.
Current flow in a p-n junction. Derivation of Shockley diode equation. Junction rectifiers – Half wave and full wave rectifiers. Applications. Basic ideas of junction diode fabrication, alloying, diffusion, ion implantation, photoengraving.
Fundamentals of bipolar transistor operation, current flow in a typical device. Input output characteristics of bipolar transistors. Transistor biasing circuits, CE amplifier, Oscillator circuits.

Textbook:

1. Seymour, J., Electronic Devices and Components, 2nd edition (Longman, 1988).
2. Simon M. Sze, Kwok K. Ng, Physics of Semiconductor Devices; 3rd Edition, Wiley, 2006.

Reference:

1. Sparkes, J.J., Semiconductor Devices (Van Nostrand Reinhold, 1987).
2. Bar Lev, A., Semiconductors and Electron Devices, 2nd edition (Prentice Hall, 1984).

Assessment:
Continuous assessment **- 50%**
Written examination. **- 50% (1 x 3 hrs**

AP 324: PHYSICS OF NON-DESTRUCTIVE TESTING

Hours per week: 6 (3 Hrs Lect / 2 Hrs Tut/1 Hr Lab)
Credits: 18

Prerequisites: AP 211

Learning Objectives:
On completion of this subject the student should be able to:-

LO1: Discuss the various kinds of mechanical Waves in solids and at interfaces

LO2: Explain how ultrasonic waves are generated and how they are used to detect imperfections in solids

LO3: Explain the physical basis of eddy current methods of defect detection

LO4: Discuss the physical basis of holography and explain how holography is employed in non- destructive testing.

Syllabus:
Ultrasonics. Review of elementary wave theory. Bulk waves in solids, longitudinal (compression) waves and transverse (shear) waves.
Polarization. Expressions for velocity of compression and shear waves.
Surface waves in solids. Free surfaces, Rayleigh waves. Dispersion relations. Liquid/Solid and solid/solid interfaces. Stoneley waves. Love waves. Lamb waves.
Acoustic impedance of boundaries. Mode conversion. Ultrasonic optics. Difraction effects. Attenuation.
Ultrasonic generators. Piezoelectric effect. Magnetostrictive effect. Electromagnetic-acoustic effect. Thermoelatic effect. Practical applications. Probe output and calibration. Distance-amplitude correction. Probe configurations. Detection and characterization of defects. Electromagnetic methods. The impedance plane diagram. Skin effect. Eddy current methods. Pulsed eddy currents. Probe design and instrumentation.
Holography. Coherence and interference of light rays. Summary of hologram types: transmission, reflection and phase holograms. Fresnel diffraction and the zone plate. Optical holography, speckle pattern interferometry. Acoustic holography. Neutron holography.

Textbook:
Halmshaw, R., Non-Destructive Testing, 2nd edition, (Edward Arnold, 1991).

Assessment:
Continuous assessment **- 50%**
Written examination **- 50%**

AP 412: MODERN OPTICS AND LASERS

Hours per week: 6(3 Hrs Lect/2 Hr Tut/1 Hr Lab)
Credits: 18,

Prerequisite: AP 352

Learning Objectives:
On completion of this subject the student should be able to:-

LO1. Define and explain basic theories of optics.

LO2. Describe coherence and interference.

LO3. Describe the different diffraction patterns.

LO4. Evaluate the principle and theory of laser and to explain the different types of lasers.

LO5. Apply the theory of optical fibre in fibre optic communication.

LO6. Explain the principle of holography and its applications.

Syllabus:
Review of electromagnetic nature of light, basic theories of reflection, refraction, interference, diffraction and polarisation, Total Internal Reflection, frustrated TIR.
Coherence and interference- Theory of partial coherence, coherence time and coherence length, coherence and line width, spatial coherence.
Diffraction- Fraunhofer and Fresnel diffraction, Fraunhofer and Fresnel diffraction patterns, high reflectance and antireflecting films.
Lasers – spontaneous emission, stimulated emission, Einstein coefficients, population inversion, Laser system, cavity configuration, mode structure and gain. Types of Lasers – Ruby laser, Nd^{3+} YAG laser, glass laser, He-Ne laser, Carbon dioxide laser, semiconductor laser, applications.
Fibre optics – Optical fibre, light propagation in step index fibre, numerical aperture, light propagation in graded index fibre, fibre losses, optical communication, sources and sensors.
Holography – Basic principle, recording of a hologram, reconstruction process, types of holograms, applications.

Textbook:
Guenther, R.D., Modern Optics (Wiley, 1990).

References:
Jones, K.A., Introduction to Optical Electronics (Harper and Row, 1987).
Watson, J., Optoelectronics (Van Nostrand Reinhold (UK) Co Ltd, 1988).
Fowles, G.R., Introduction to Modern Optics (Holt, Rinehard and Winston, 1968).

Assessment:
Continuous assessment **- 50%**
Written Examination **- 50% (1x3 hours)**

AP 413: RADIATION PHYSICS

Hours per week: 6(3 Hrs Lect/2 Hr Tut/1 Hr Lab)
Credits: 18,

Prerequisite
Learning Objectives:
On completion of this subject the student should be able to:-

LO1. Contrast the theoretical aspects of alpha, beta, gamma decay process.

LO2. Eaxmine the techniques used in charged particle acceleration and some accelerator types;

LO3. Examine the different nuclear analytical methods and the domain of application of each;

LO4. Examine the general principles of the application of nuclear radiation to problems in mining, industry, medicine and the environment.

LO5. Examine the practical aspects of radiation shielding, protection, laboratory managemnet and detectors available on the market.

LO6. Examine the transport and management of radioactive waste disposal methods and updated technology development and useful application of radiation energy.

Syllabus:
Alpha, beta and gamma decay processes. Theory of gamma decay, quantum mechanical tunnelling, the Gamow factor, alpha decay spectroscopy. Types of beta decay processes, x-rays following beta decay, the Fermi theory of beta decay.
Energetics of gamma decay, internal conversion, isomeric transitions, branching ratios and lifetimes of excited states. Review of the interaction of gamma rays with matter.
Charged particle acceleration. Ion sources and principles of acceleration. A survey of accelerator types.
Dosimetry and spectroscopy. Measurement units and dosimeters, Scintillation detectors; NaI (T1) detector, characteristics and resolving time; liquid scintillation counting, quenching. Solid state detectors, the HPGe and HPSi detectors. Photopeak efficiencies and multichannel pulse height analysis. Detector resolution. Nuclear analytical methods.
Thermal and fast neutron activation, neutron sources and neutron reactions, reaction cross sections, energy dependence, resonance. Neutron activation analysis, applications. X-ray fluorescence analysis, the yield equation, sources, domain of application, analytical parameters. Track analysis, principles, fission and charged particle tracks, radon measurements.
Isotope dilution and solvent extraction methods of radiometric analysis.
Radiation shielding and protection. Attenuation coefficients and half thicknesses, neutron shielding. Maximum permissible

doses.Radioactive waste disposal. Decontamination procedures.

Textbook:
Krane, K.S., Introductory Nuclear Physics, (J. Wiley and Sons, 1988).

Reference:
Knoll, G., Radiation Detection and Measurement, (J. Wiley and Sons, 1989).

Assessment:
Continuous Assessment **- 50%**
Written Examination **- 50% (1x3hrs)**

AP 414: EXPLORATION GEOPHYSICS I

Hours per week: 6(3 Hrs Lect/2 Hr Tut/1 Hr Lab)
Credits: 18,

Prerequisite: AP223, AS 112, EN 212

Learning Objectives:
On completion of this subject the student should be able to:-

LO1: Describe briefly the interior of the Earth and the basis of its stratification.

LO2: Describe how Earth's gravity field accounts for the internal mass distribution and how isostatic compensation accounts for the surface undulation of the Earth.

LO3: Explain the origin of geomagnetic fields, the effects of both internal and external variations and Earth's rotation

LO4: Explain how seismology reveals the broad divisions of the Earth into crust, mantle and core, how this discipline provides the most certain information on the parts of the Earth which can not be directly examined

LO5: Establish a time scale for events in the past history of the Earth and to show how the varying distribution of the products of radioacative distribution provides a means of tracing the history of minerals.

LO6. Explain detailed characteristics of the modern concepts of plate tectonics and continental drift.

Syllabus:

Gravity exploration: Figure of earth, Basic concepts, working principle of gravity meters, field procedures, different corrections applied to get Bouguer gravity anomaly, contouring principles, interpretation of gravity anomalies, Regional-residual separation, anomalies due to bodies of simple geometric shape, direct and indirect interpretation, case histories.

Magnetic exploration: Basic concepts, dipole magnetic field of earth, Geomagnetic field components, exploration in search of oil & minearals, magnetic susceptibility of rocks, different type of magnetometers and its working principles, field surveys on land, airborne and shipborne, diurnal and Geomagnetic correction, qualitative and quantitative magnetic anomaly interpretation, depth rule, basement mapping over sedimentary basins, fault and antic lines detection, case histiry of search of HC and minerals

Self potential methods: Origin of self potential in nature, geologic applications, SP instrumentation and field survey procedures, SP anomalies and its interpretation for minerals particularly sulphide ore prospecting.

Textbook:
Garland, G.D., Introduction to Geophysics, 3rd edition (W.B. Saunders Co., 1982).

Reference:
Bullen, K.E. and Bolt, B., An Introduction to Seismology, 4th edition (Cambridge University Press, 1986). Aki, K. and Richards, P.G., Quantitative Seismology - Theory and Methods, (Freeman, 1980). Kenneth, B.L.N., Seismic Wave Propagation in Stratified Media, (Cambridge University Press, 1983).

Assesement:
Continuous Assessment **- 50%**
Written examination **- 50% (1x3 hrs)**

AP 421: PROJECT

Hours per week: 6 (6 Hr Project)
Credits: 8,

Learning Objectives:
On completion of this subject the student should be able to:-

LO1: Design and carry out a simple research work.

LO2: Plan an experiment with accuracy appropriate to its purpose.

LO3: Collect and interpret obtained results.

LO4: Take steps to minimise errors in methods and instruments.

LO5: Write a standard report on the project work.

Syllabus:
Students carry out research on approved project proposals, collect data and interpret research results. Students give seminars on research findings, write the final standard reports on the project work and submit reports to examiners for assessment.

Assessment:
Continuous Assessment **- 100%**

AP 422: INDUSTRIAL TRAINING

Hours per week: Required 6 weeks industrial training accumulated during the vacations of the BSAP course

Credits: 8

Prerequisite: Enrollment as 2^{nd} and 3^{rd} year AP student

Learning Outcomes:
On completion of this subject the student should be able to:-

LO1. Ability to Explain and get familiar with aspects of industrial activities and facilities in PNG

LO2. Develop skills to work as a practical Applied Physicist;

LO3. Develop skills to write a detailed technical report.

Syllabus:
Training in industry. Perform a short practical project. Write a technical report on the project.

Assessment:
Continuous Assessment **- 100%**

AP 424: ENERGY SOURCES

Hours per week: 6(3 Hrs Lect/2 Hr Tut/1 Hr Lab)
Credits 18: Core

Prerequisite: AP 212

Learnng Outcomes:
On completion of this subject the student should be able to:-

LO1. Explain the different types of energy sources and their classification

LO2. Ability to understand and provide a description of a general electricity generation system. And be able to give examples of renewable and non-renewable energy sources

LO3. Describe and analyze basic fluids dynamics and application of Bernoulli's equation

LO4. Apply appropriate methods for calculation of behaviour of fluids

LO5. Explain and Evaluate energy transfer by mechanical or electrical processes

LO6. Understand how energy is obtained from the wind, the oceans and the Earth's interior

LO7. Apply basic calculations to understand the different types of energy sources

LO8. Understand the mechanism for generation of electricity by the different energy sources to be able to organize and structure a learning portfolio

Syllabus:

Energy sources fundamental and different types of energy sources

Essentials of fluid dynamics: Bernoulli's equation and its applications

Energy transfer by mechanical or electrical processes

Description of the different types of electricity generation from different energy sources.

Basic designs of different systems of power generation: photovoltaics, wind, biomass etc

Textbook:
Twidell, J.W. and Weir, A.D., Renewable Energy Resources (C.U.P., 1986).

References:
G. D. Rai; Non-conventional energy sources; Khanna Publishers, Delhi-6.
Volker Quaschning; Understanding Renewable Energy Systems; Earthscan, London, Sterling VA
J.F. Manwell, J.G. MsGowan, A.L. Rogers; Wind Energy Explained, John Wiley & Sons 2002
Tomas Markvart, Solar Electricity; John Wiley and Sons

Assessment:
Continuous Assessment **- 50%**
Written Examination **- 50% (1x3 hours**

AP 425: EXPLORATION GEOPHYSICS II

Hours per week: 6(3 Hrs Lect/2 Hr Tut/1 Hr Lab)
Credits: 18,

Prerequisite: AP223, AS 112, EN 212

Learning Objectives:
On completion of this subject the student should be able to:-

LO1. Brief overview of mineral exploration and ground water prospecting from electrical resistivity and seismic refraction survey

LO2. Gain knowledge about horizontal/lateral discontinuity in resistivity used for ore prospecting in subsurface by the help of profiling.

LO3. Acquire knowledge about vertical discontinuity in resistivity used for measurement of resistivity of layered earth for ground water prospecting and other engineering construction

LO4. Gain knowledge how resistivity sounding can help in construction of dam, high Retained all subject contents ways, tunnelling etc. in civil engineering.

LO5. Seismic refraction is also very important technique for ground water exploration from velocity analysis

LO6. Seismic reflection survey is used extensively for hydrocarbon exploration either in onshore or offshore.

Syllabus:

Electrical resistivity method: Resistivity of rocks and minerals, resistivity meters, Field survey procedures, Profiling and sounding techniques, Wenner, schlumberger and dipole-dipole survey, resistivity data analysis and interpretation techniques, case history

Seismic exploration: Elements of seismic surveying, seismic waves, ray paths in layered media, seismic velocities, Refraction and reflection survey, seismic instrument , working principle of geophone, recording system, field procedure, time-distance curves for refracted and reflected waves, Static corrections to seismic traces, velocity analysis, filtering of seismic data, multi channel and common mid point gather, overview of seismic data processing, case history

Textbook:
Garland, G.D., Introduction to Geophysics, 3rd edition (W.B. Saunders Co., 1982).

Reference:
Bullen, K.E. and Bolt, B., An Introduction to Seismology, 4th edition (Cambridge University Press, 1986). Aki, K. and Richards, P.G., Quantitative Seismology - Theory and Methods, (Freeman, 1980). Kenneth, B.L.N., Seismic Wave Propagation in Stratified Media, (Cambridge University Press, 1983).

Assessement:
Continuous Assessment **- 50%**
Written examination **- 50% (1x3 hrs)**

AP 426: PHYSICS OF THE ENVIRONMENT

Hours per week: 6 (3 Hrs Lect/2 Hr Tut/1 Hr Lab)
Credits: 18,

Prerequisite: AS 132

Learning Objectives:
On completion of this subject the student should be able to:-

LO1: State the scope of environmental physics;

LO2: List the main parameters that determine the survival of the species in the physical environment of plants and animals;

LO3: Explain the behaviour of a system and state the simplest way of describing it in terms of governing concepts such as Boyle's Law and Newton's Laws of motion;

LO4: Explain the central notion of the exchange of radiation, heat, mass and momentum between organisms and their environment;

LO5: Describe rates of various transfer and exchange between organisms and their environment by electrical analogues or use of Ohms Law.

Syllabus:
Fluid mechanics; mass and energy/momentum conservation, continuity and Bernoulli's equations, types of flow, viscosity analysis in fluid flow, Reynolds and Prandtl numbers.
Heat Transfer: Modes of heat transfer; conduction, convection (forced and free), radiation; absorption, reflectance and transmission in radiative heat transfer.
Solar Radiation: Solar radiation and calculations, atmospheric absorption, greenhouse effect, global warming. Practical applications in Environmental remote sensing using passive and active sensing systems are also addressed
Atmospheric Physics: Kinetic theory of gases, gas laws, adiabatic lapse rate, dew point, relative humidity, water vapour, vapour pressure, El nino and southern oscillations, weather systems.
Oceanography: Equation of motion in oceanography, equation of continuity of volume, Properties of sea water; temperature, pressure and salinity

Textbook:
Monteith, J.L. and Unsworth, M.H., Principles of Environmental Physics, 2nd edition (Chapman and Hall, 1990).

Assessment:
Continuous Assessment **- 50%**
Written Examination **- 50% (1x3hrs**

BACHELOR OF ENGINEERING IN BIOMEDICAL ENGINEERING

First Year First Semester

Code	Subject	Contact Hours	Credit
AP111	Introductory Physics I	6	17
AS111	Foundation Chemistry	6	**15**
EN112	Engineering Mathematics I	6	**22**
CD112:	English Grammar & Composition I	6	**15**
		24	**69**

First Year Second Semester

Code	Subject	Contact Hours	Credit
AP121:	Introductory Physics II	6	17
AS112:	Introduction to Applied Chemistry	6	15
EN121:	Engineering Mathematics II	6	22
CD126:	English Grammar & Composition II	6	15
		24	**69**

Second Year First Semester

Code	Subject	Contact Hours	Credit
EN212:	Engineering Mathematics III	6	18
AP211:	Circuit Theory	6	18
BE211:	Human Anatomy and Physiology I	6	18
CS214:	Introduction to Programming	6	19
		24	**73**

Second Year Second Semester

Code	Subject	Contact Hours	Credit
BE221:	Atomic and Nuclear Physics	6	18
BE222:	Human Anatomy and Physiology II	6	18
AP221:	Thermodynamics and Cryogenics	6	18
EE221:	Digital Logic Systems	6	19
		24	**73**

Third Year First Semester

Code	Subject	Contact Hours	Credit
EE341:	Computer Architecture	6	19
BE311:	Biomedical Instrumentation I	6	18
BE321:	Transport Phenomena in Biological Systems	6	18
AP313:	Programmable Devices	6	18
		24	**73**

Third Year Second Semester

Code	Subject	Contact Hours	Credit
BE321:	Digital Signal Processing for Biomedical Application	6	18
BE323:	Pathology and Microbiology	6	18
AP323:	Physical Electronics	6	18
BE322:	Biomaterials	6	18
		24	**72**

Fourth Year First Semester

Code	Subject	Contact Hours	Credit
AP412:	Modern Optics & Lasers	6	18
BE412:	Medical Imaging I	6	18
BE413:	Biomedical Instrumentation III	6	18
EE411:	Instrument Systems for Process Control	6	19
*BE411:	**Project**		
		24	**73**

Fourth Year Second Semester

EE421:	Instrumentation and Process Control	6	21
BE422:	Medical Imaging II	6	18
BE423:	Sensors and Actuators	6	18
BE424:	Installation, Maintenance and service	6	18
BE 412:	Project 11	**6**	**8**
*BE 425	Industrial Training		
		30	**83**

***BE 411 is a final year project which the students should undertake immediately, however will not be assesses until the the second semester.**

***BE 425: Industrial Training -Work integrated Learning will be in Sem 2, Year 3 Nov-Jan.**

The Biomedical Engineering Graduate will fabricate, maintenance and service, research, design, built biomedical instruments and ensure sustainability of patient care.They will be future focus in innovative and entrepreneurial in creating tools of patient care using available resources.The Graduates will easily integrate into any working environment.

COURSE LEARNING OUTCOMES (CLOs)

1	Ability to identify, analyse, fabricate , maintenance and service, research,design and build biomedical instruments and other test systems for patient care.
2	Ability to describe, explain, and communicate effectively to others, as well as ability to prepare formal technical plans and reports detailing solutions of problems in addressing patient care.
3	Ability to understand and recognize the need for, to engage in life-long learning to continuously upgrade their knowledge to a higher learning via research activities, personal readings and by attending short seminars and workshops from time to time.
4	Ability to work on multidisciplinary teams and understand the scope of work and issues that allow the team to achieve their goal.
5	Ability to apply the knowledge of mathematics and Physics and science in general, in all aspects related to biomedical systems sustainability.
6	Ability to design and conduct experiments, as well as to analyse and interpret data collected.
7	Ability to conduct and manage projects in multidisciplinary environments and apply appropriate techniques and skills, as well as project management concepts and tools necessary to complete those projects with success.
8	Broad knowledge and understanding of contemporary issues due to the changing of global economy, environmental impact of those changes, and the social context involved in sustaining health care.
9	Develop an understanding of professional, safety and ethical responsibility at all times in health care and related.
10	Ability to conduct experiments or lead researches especially in academia and analyze data to come up with useful conclusions and recommendations in relation to improve the academic environment in teaching and learning.

AP111: Introductory Physics I

Hours per week: 6 (3 Hr Lectures /1 Hr Tutorial /2 Hr Lab)
Credits: 17

Pre-requisite: Grade 12

Learning Outcomes:
On completion of this subject the student should be able to:-

LO1. Explain the basic fundamental units.

LO2. Analyse and solve simple problems in kinematics.

LO3. Evaluate the equations of force and motions

LO4. Analyses different types of waves.

LO5. Calculate equations involving properties of matter.

LO6. Develop skills in team work to solve equations of fluids and dynamics.

LO7. Analyse and solve equations involving gas and matter expansions and the cooling processes.

Syllabus:
Fundamental Units of Scalars, Vectors and Quantities: Units of measurements, physical quantities, dimensional analysis, scalar and vector quantities. and units, significant figure, errors in measurements.
Kinematics: Concepts of motion, velocity and acceleration as vectors. Motion in one and two dimensions; projectile motion and circular motion.
Force and Motion: Dynamics of a particle. Concepts of mass, force, impulse and momentum. Rotational motion of a rigid body; moments of inertia, angular momentum, torque.

Oscillations and Waves: Simple Harmonic Motion (SHM). The kinetics and dynamics of SHM. Energy in SHM. Application to spring problems and the pendulum. Damped and forced oscillations. Classification of wave motion. Travelling waves, Superposition of waves, equation of a progressive wave, wave length and phase difference. Beats: the phenomenon of beats.
Stationary(standing) waves: the formation and properties of stationary waves. Velocity of sound in gases: Newton's formula, Laplace correction. The Doppler effect: derivation of expression for freqency change, the Doppler effect with light.

Properties of matter: Elasticity, Stress, strain, moduli of elasticity, Poisson's ratio. Surface tension, Excess of pressure inside curved surfaces.

Fluid Dynamics: Basics concepts of ideal flow, Continuity equation, Bernoulli and momentum equations, Streamline flow and turbulent flow, Reynold's number, Viscosity.

Thermometry and calorimetry: temperature scales, heat capacity, measuring specific heat capacities, latent heat. Gases: the gas laws, ideal gas equation, the kinetic theory of gases. Avogadro's law, external work done by an expanding gas, isothermal processes, adiabatic processes. Heat transfer: thermal conduction, definition of thermal conductivity, thermal radiation, the concept of black body, convection. Stefan's law, Newton's law of cooling.

Textbook:
Young, H.D. University Physics, 8th Edition (Addison-Wesley, 1992).

Assessment:
Continuous Assessment - **50%**
Written Examination - **50% (1x3 hrs)**

AP 121: Introductory Physics II

Hours per week: 6 (3 Hr Lectures /1 Hr Tutorial /2 Hr Lab)
Credits: 17

Pre-requisite: AP 111

Learning Outcomes:

On completion of this subject the student should be able to:-

LO1. Apply the concepts of electrostatics to simple point and continuous charge distributions.
LO2. Calculate currents in branched circuits.

LO3. Apply the laws of electromagnetism to simple problems.

LO4. Discuss Geometrical Optics concepts related to lenses, mirrors, and basic optical instruments.

LO5. Describe and solve problems related to waves concepts applied to electromagnetic waves.

LO6. Discuss the wave properties of light.

Syllabus:

Electrostatics: Concepts of charge and electric field. Coulomb's law. Gauss' law. Calculations of electric field for discrete and continuous charge distributions. Electrostatic potential.
Capacitance and Current electricity: Ohm's law. Electromotive forces, the circuit equations, Kirchoff's rules.
Magnetism: Magnetic force on current-carrying conductors, the electric motor. Magnetic field due to a current, the Biot-Savart law. Force between currents, the Ampere. Laws of electromagnetic induction. Application to the dynamo, eddy currents. Self-inductance, energy stored in an inductor.
Geometrical Optics: Refraction: laws of refraction. Lenses and mirrors: basic properties, images, determination of focal length, lenses and mirrors formula, etc.
Electromagnetic waves: electromagnetic spectrum.
Wave properties of light. Wave front. Interference of light waves. Young's double-slit experiment. Diffraction of light waves, diffraction at a single slit, diffraction produced by multiple slits. Polarization of light waves.
X-rays: Production, Bragg's law. Atomic spectra, Nucleus, Radioactivity, Nuclear fission, fusion.

Textbook:

Young, H.D. University Physics, 8th Edition (Addison-Wesley, 1992).

Assessment:
Continuous Assessment - **50%**
Written Examination **- 50% (1x3 hrs)**

AP 211: CIRCUIT THEORY

Hours per week: 6 (3 lectures/2Tut/1 lab)
Credits: 18, Core

Prerequisites: AP121, EN121

Learning Outcomes:
On completion of this subject the student should be able to:-

LO1. Define and explain basic circuit elements.

LO2. Describe and analyse each type of circuits and its basic theories.

LO3. Apply appropriate methods for calculation in solving different types of circuits.

LO4. Evaluate each laws and theorems such as Ohm's law, Kirchhoff's law, mesh and nodal analysis, Thevenin's and Norton's theorems and other methods of solving problems.

LO5. Apply the theorems in both series and parallel circuits using ac and dc circuits in Ohmic, inductive and capacitive circuits.

LO6. Explain different time constants and waveforms, resonance circuits and filter circuits with its response curve.

Syllabus:
Electrical conduction in metals, resistance, ohms laws, Kirchhoff's rules, Application to series and parallel circuits. Transients in RC circuits, Response to d.c. voltages, Time constants, Applications to time base and pulse shaping, Measurement of high resistance by capacitor leakage

Mesh and Nodal Analysis of d.c. circuits, Analysis of circuits with current sources and resistors, Thevenin's theorem; Norton's theorem; Millman's theorem. voltage across the resistor, capacitor and inductor, Active and passive elements. Vector Impedance diagrams.
Complex number representation, Power in a.c. circuits, The resonance condition, Nodal and mesh analysis for a.c. circuits.

Textbook:

Bernard Grob, Mitchel E. Schultz , Basic Electronics, 9th edition, (McGraw-Hill, 2003).

Assessment:

Continuous Assessment **- 50%**
Written examination **- 50% (1 x 3 hrs)**

BE211: HUMAN ANATOMY AND PHYSIOLOGY I

Hours per week: 6 (3 lectures/2Tut/1 lab)
Credits: 18,Core
Prerequisite: Gr.12

Learning Outcomes:

On completion of this subject the student should be able to:-
LO1: Compare and identify features, locations and major functions of the primary tissues of the human body.

LO2: Identify and describe features of the human skeleton and recognize variability that can occur within the skeleton.

LO3: Identify the different muscle groups within the human body and identify different characteristics between different cell types.

LO4: Identify and describe the macroscopic features, locations, relationships and major functions of the organs and body structures of the organ systems of the human body by applying accurate anatomical terminology and relate structure to function.

LO5: Apply facets, concepts, theories and terms related to disease processes.

Syllabus

Cell:
Muscle: Muscles& Major muscle groups Bone: Identification of bones and associated features Tissue: bone tissue, cartilage &nervous tissue, Macroscopic and microscopic study of epithelial tissue.

Cardiovascular System: Macroscopic and microscopic features of arteries, veins and capillaries

Lymphatic system, Nervous system,Digestive system,Urinary system, Respiratory system, Endocrine system
Male and female reproductive system.
Introductory Pathology: Cellular adaptation and cell death, inflammation and repair, infection, circulatory disorders, immune defense, genetics of disease and neoplasia.

Textbook:

1. Macdonald, B.W. & Gregory, L., LSB145 Anatomy 1 Teaching & Learning Manual, QUT Publishing (2009).

Reference books:

1. McKinley, M. &O'Loughlin, V.D., An Anatomy, McGaw Hill (2008).
2. Allen, C. & Harper, V., Laboratory Manual for Human Anatomy, John Wiley & Sons (2005).
3. Mosby's Medical, Nursing and Applied Dictionary, 5th Edition, Mosby (1998).

Assessment:

Continuous Assessment **- 50%**
Final Examination **- 50% (1x3 hrs.)**

BE221: ATOMIC AND NUCLEAR PHYSICS

Hours per week: 6 (3 lectures/2Tut/1 lab) Credits: 18, Core
Prerequisites: Gr.12 Learning Outcome:

On completion of this subject the student should be able to:-

LO1. Solve problems based on the energy units used in atomic physics, and be able to convert from one to the other;

LO2. Explain - particle scattering experiments and their bear ing on atomic structure;

LO3. State the constituents of the nucleus, and the nature of nuclear forces;

LO4. Explain the significance of nuclear binding energies and solve simple problems on them;

LO5. Interpret the stability (N-Z) curve and state the proper ties of the radiations given off in radioactive decay;

Lo6. State the ways of artificially producing radioactive substances, and also states some of the uses of such substances.

Syllabus:

Energy units. The joule, electron-volt (eV). Relativistic mass- energy relation. The atomic mass unit (amu) as an expression of energy. Relation between amu and MeV. Atomic constituents.

Alpha-particle scattering and the Rutherford model. Atomic spectra. Bohr theory and the hydrogen spectrum. X-rays: nature, production and uses. Diffraction of x- rays. The continuous and characteristic spectrum. Moseley's work on x-rays and its significance. Interaction of x-rays with matter, Compton scattering. The atomic nucleus. Nucleons and nuclear forces. Nuclear mass and abundance of nuclides. Mass defect. Nuclear binding energy and its significance. Nuclear models. The liquid-drop, shell, and collective models treated qualitatively. Nuclear stability. The N-Z curve.

Radiations from radioactive substances, alpha, beta and gamma radioactivity. Transmutation equations following decay. Equations of radioactive decay. The decay law. Half life and disintegration constant. Secular equilibrium and the radioactive series. Radioactive dating. Cosmic rays. Natural background. Production of radioisotopes. Uses of radioisotopes in industry, medicine, mining, agriculture etc. Principles of radiation detection. Ionisations and excitations. Survey of detector types. Gas-filled, scintillation, and semiconductor detectors. Measurement statistics and detector resolving times.

Examination of the role of the International Commission on Radiological Protection

Codes of practice associated with radiation workers

Short and long term effects of radiation exposure at a cellular, whole body and population level

Radiation protection apparatus and considerations for departmental design including radioisotope laboratories

Considerations for pregnant patients during delivery of radiation therapy. Natural sources of radiation and contamination monitoring.

Text books:

1. Littlefield, T.A. & Thorley, N., Atomic and Nuclear Physics, 3rd edition, (ELBS and van Nostrand Reinhold Co., 1979).

2. Noz, M.E., & McGuire, G.O., Radiation Protection in the Radiologic and Health Sciences, Lea &Febiger (2005).

Reference books:

1. Bushong, S.C., Radiologic Science for Technologists, 9th Edition, Mosby (2007).

2. Coggie, J.E., Biological Effects of Radiation, 6th Edition, Taylor & Francis (2006).

3. Hall, E.J., Radiobiology for the Radiologist, 7th Edition, JB Lippincott, Williams and Wilkins (2007).

Assessment:

Continuous Assessment - **50%**
Written Examination - **50% (1x3 hrs)**

BE 222: HUMAN ANATOMY AND PHYSIOLOGY II

Hours per week: 6 (3 lect/2 Tut/1 lab)
Credits: 18, Core
Prerequisite: BE211

Learning Outcomes:

On completion of this subject the student should be able to:-

LO1: Describe the anatomy of the organs and structures that localized within the upper and lower limbs, head and neck regions

LO2: Identify these structures using anatomical models, photographs of axial (cross) sections and illustrations.

LO3: Identify the major structures of the head, neck and upper and lower limbs in magnetic resonance, computerized tomography, and plain and contrast radiographic images in a variety of anatomical planes.

LO4: Describe the radiographic appearance of the major structures of the head, neck and upper and lower limbs in radiographs and computer tomography images and signal intensity of these structures in magnetic resonance images.

LO5: Identify anatomical structures within the chest, abdomen and pelvis

LO6: Provide anatomical detail about each organ of interest in the sites mentioned in LO5

LO7: Use of various imaging modalities such as diagnostic x- ray, computed tomography and magnetic resonance imaging

LO8: Identify the various structures within the chest, abdomen and pelvis in the imaging modalities mentioned in LO7.

Syllabus:
Upper Limb: osteology, radiographic anatomy, regional and surface anatomy, blood and lymphatic vessels, MRI and axial sectional anatomy

Lower Limb: osteology, radiographic anatomy, regional and surface anatomy, blood and lymphatic vessels, MRI and axial sectional anatomy.

Head and Neck: osteology; radiographic anatomy surface anatomy, regional and surface anatomy blood vessels, nerves and lymphatics. Regional and imaging anatomy of the Back:
Relevant osteology; muscles and ligaments of the back
Content of the vertebral column including spinal cord, meninges and spinal nerves

Plain radiographic anatomy, myelography; computerized tomography of the lumbar region
MRI of the vertebral column and its contents. Regional and Imaging anatomy of the Thorax:

Relevant osteology, thoracic wall, lungs and pleura, and the mediastinum
Axial sectional anatomy, plain radiographic anatomy, coronary arteriography, mammography; computerized tomography

Regional anatomy of the Pelvis and Perineum: Pelvic wall, male and female pelvic organs,
Contents of the male and female perineum, axial sectional anatomy.

Imaging anatomy of the Abdomen and Pelvis:
Plain radiographic anatomy, computerized tomographic anatomy and contrast radiographic anatomy of the gastrointestinal tract, urinary, biliary tract, uterus and uterine tubes.

Text books:
1. Macdonald, B.W & Gregory, L., LSB345 Regional and Imaging Anatomy 1, Teaching and Learning Manual (updated annually), QUT Publications (2009).

Reference books:
Moore, K.L. &Dalley, A.A., Clinically Oriented Anatomy, 5th Edition, Williams and Wilkins Publishers (2006).
Weir, J. & Abrahams, P.H., An Imaging Atlas of Human Anatomy, 4th Edition, Wolfe Publishers (2005).

Assessment:

Continuous Assessment **- 50%**
Written Examination **- 50% (1x 3 hrs.)**

AP 221: THERMODYNAMICS AND CRYOGENIC

Hours per week: 6 (3 Hrs Lecture/2 Hr Tut/1 Hr Lab) Credits: 18
Prerequisite: AP121, EN212

Learning Objectives:
On completion of this subject the student should be able to:-
LO1. Define concepts of thermodynamics such as isolated, closed and open system, thermodynamic equilibrium, quasi-static and non-quasi-static process, etc;

LO2. State the laws of thermodynamics and discus some of the consequences of the first and second laws of thermodynamics;

LO3. Thermodynamics refrigerant properties.
LO4. Principles of air conditioning. The heat pump.
LO5. Cryogenic systems. Cryogenic Electrical and Electronic control circuitry
LO6. Cryogenic instrumentation and equipment selection

Syllabus:
Scope of Thermodynamics, thermodynamic System, thermal equilibrium
Laws of thermodynamics, Consequences, Equation of state of an ideal and real gas. Internal Energy, Enthalpy, Heat capacity, Entropy,
Temperature-Entropy Diagram. The Principle of increase of entropy, third law of thermodynamics.
Thermodynamics refrigerant properties.
Principles of air conditioning. The heat pump. Cryogenic systems. Cryogenic instrumentation and equipment selection

Textbook:
1. Sears, F.W. and Salinger, G.L., Thermodynamics, Kinetic Theory and Statistical Thermodynamics, 3rd edition (Addison-Wesley, 1975).

Reference:
Zemansky, M.W. and Dittman, R.H., Heat and Thermodynamics, 6th edition (McGraw-Hill, 1981).
Mandl, F. 1988, Statistical Physics, 2nd edition, Wiley. Finn, C.B.P., 1993. Thermal Physics, Chapmann and Hall.

Assessment:
Continuous Assessment **- 50%**
Written Examination **- 50% (1 x 3 hrs)**

EE 341: COMPUTER ARCHITECTURE

Hours per week: 6 (4 hrs Lectures + 2 hr Lab)

Credit: 19

Prerequisite: EE241, EE242

Learning Outcomes:
On completion of this subject the student should be able to:-

1. Describe the Von Neumann architecture and be able to detail the subsystems found in modern PC architectures.
2. Discover the working components of a microprocessor; defining the CPU instruction set and hardware resources.
3. Analyse the interactions between CPU, memory and I/O subsystems.
4. Provide a detailed description of the function of a number of commercially available 16 and 32 bit microprocessors and their bus systems, including their memory and I/O architectures.
5. Differentiate between software and hardware interrupts and explain the function of interrupt vector tables.
6. Describe and analyse the system design for the IBM PC, at a hardware and firmware level. This will include basic hardware design, BIOS structure, major subsystem interface requirements as well as the DOS disk structure.

Syllabus:

Computer architectures, hardware and software. CPU, ALU, memory, I/O.Bus architectures, I/O structure, interrupts. The inner workings of an IBM PC.

Textbook:

1. Mazidi, M.A., Mazidi, J.G., Causey, D. The x86 PC: assembly language, design and interfacing, 5th Edition, Prentice Hall, 2010

Assessment:

Continuous Assessment **- 50%**
Written Examination **- 50%(1x3hrs)**

BE311: BIOMEDICAL INSTRUMENTATION 1

Hours per week: 6 (3 hrs Lect/2hrs Tut/ 1 hr Lab)

Credit: 18

Pre-requisite: None

Learning Outcomes:

On completion of this subject the student should be able to:-

1. Understand basic operating principals of various medical and laboratory equipment.
2. Read and get measurements.

Syllabus:

Basic principle, technical specification, working and applications of Analytical and Laboratory Instruments. Spectrometer, Blood cell counter, colorimeter, Electrophoresis, pH meter, Chromatography and spectroscopy, Cell and Plasma Separator, Autoanalyser,Centrifuge,Microscopes, Electrolyte Analyser, Elisa reader and Wash.

1. **Blood Gas Analyser:**
   Measurements of Blood pH, pCo2pO2 and complete Blood Gas analyser.
2. **Blood Flow Measurement:**
   Electromagnetic, Ultrasonic, NMR and Laser Doppler flow metry, cardiac output measurement, impedance plethysmography.
3. **Pulmonary Function Analyser and Ventilator:**
   Respiration measurement technique: Lung volume and capacities. Spirometry, Pulmonary function measurement and analyser, spirometer and respiratory function analyser. Oximetry, Ventilators Respiratory Theraphy Equipment and Anesthesia Equipment
4. **Heart Lung machine**
5. **Audiometers:**
   Basic audiometer, Pure tone and Speech audiometer, evoked response Audiometry.

Text Books:

Handbook of Biomedical Engineering by R.S. Khandpur (TMH Pub).

Assessment:

Continuous assessment: **-50%**
Written examination: **-50% (1x3 hrs)**

BE312: TRANSPORT PHENOMENA IN BIOLOGICAL SYSTEMS

Hours per week: 6 (3 hrs Lect/ 2 hrs Tut/2 Hr Lab)

Credit: 18

Pre-requisite:

Learning Outcomes:
On completion of this subject the student should be able to:-

1. Apply knowledge of biological and physical sciences, mathematics, and engineering to solve problems at the interface of engineering and biology.
2. Identify, formulate and solve biomedical engineering problems that address contemporary issues within a global societal and economic context.
3. Recognize the need to pursue continuing educational opportunities in biomedical engineering and have the ability to do so.

Syllabus:
Conservation of heat, mass and momentum plus the associated constitutive laws; knowledge of constitutive data unique to loving systems including their magnitude and scale. How to determine which laws and data are relevant to a specific biological system and process; how to apply these laws to the solution of biological problems; development/refinement of effective general engineering problem definition and solving skills leading to adaptive expertise.

Textbooks:
1. BE435 Course Packet (Will be available in ERB 220 with Christen Bailey.
2. Fundamentals of Heat and Mass Transfer-Seventh Edition (By Incropera, DeWill, Bergman and Lavine).

Assessment:

Continuous assessment	**-50%**
Written examination	**-50% (1x3)**

AP313: Programmable Devices

Hours per week: 6 (3 Hrs Lect/2 Hr Tut/1 Lab)
Credits: 18,
Prerequisite: EE221

Learning Objectives:
On completion of this subject the student should be able to:-

LO1. Explain and review the digital logic systems.

LO2. Describe the electronic components of semiconductor devices

LO3. Explain the different integrated circuits and their operations.

LO4. Apply the fundamental theory of input/output interface modules and the assembly language.

LO5. Describe the theory of microprocessors and microcontrollers and its operation.

LO6. Explain how the microcontrollers receive instructions to perform its operation.

Syllabus:
Review of digital logics, Semiconductor diodes, BJT, FET, MOSFET, Digital circuit and combinational logic, Sequential logic and flip-flops, ADC & DAC, Data acquisition systems, Memory systems, Case studies of electronic systems like microprocessors.

Integrated circuits, TTL and MOS logic circuits, Gating Networks Logic design: Flip – Flops Transfer circuits, Clocks, shift registers, Counters, State diagrams and State tables, Magnitude comparator, Programmable Arrays of Logic cells.
Elements of ALU Design and implementation of Binary Address (Half and Full) and Subtractors, BCD Adder, Multiplexer, encoder, decoder, Floating point number systems, Arithmetic operations with Floating point numbers.

Input – output interface modules, I / O versus memory bus, isolated versus memory, mapped I / O, asynchronous data transfer, direct memory access (DMA), input-output processor (IOP): CPU, IOP communication, memory organization.

Microcomputers, microprocessor and assembly language, microprocessor architecture and microcomputer systems: microprocessor architecture and its operations, memory, input and output, 8085 MPL, 8085 based microcomputer, memory interfacing.

The 8085 programming model, addressing techniques, 8085 instruction, code conversion, BCD arithmetic operations.

Microcontrollers-8051, Microcontroller-architecture-special function registers, addressing modes, instruction set.

Origin of PIC Micro:- Introduction to PIC micro-Architecture and hardware, block diagram, working registers, program memory, data memory, file registers, program concepts of status register, stack file selection register, option register, indirect data addressing register, digital I/O port, clock oscillators, timer modules, pre-scalar, watch dog timer, reset circuitry, instruction cycle, long word instruction, power down mode sleep, configuration fuses
Instruction set and program development:- Instruction set types, MPASM, source code formats, labels, mnemonics, operands, comments, files with default extension, lists file format, error file format (EPR), operators , procedure , text strings, numeric constants and radix key to PIC 16/17 form instruction sets.

Textbooks:

1. Mathur, A. P., Introduction to Micrprocessor, T.M.H. 1990.
2. Bartee, T. C.,Digital Computer Fundamentals,, T.M.H. 6th edition 1991.
3. Ramesh, A., &Goankar, S.,.Microprocessor Architecture, Programming and Applications with the 8085/8080 Wiley Eastern Ltd.

4. Salivahanan, S., Vallavaraj, A. & and Gnanapriya,C., Digital Signal processing, Tata McGraw Hill
5. Embedded control hand book, volume 1995/96
6. PIC 16/17 microcontroller data book, volume 1996/1997

References:

1. Hall, D. V., Microprocessors and interfacing – Programming and Hardware, TMH, 1997.
2. Mano, M. M., Computer System Architecture, 3rd ed., PHI.

Assessment:
Continuous Assessment **- 50%**
Written Examination **- 50% (1x3 hrs)**

BE321: DIGITAL SIGNAL PROCESSING FOR BIOMEDICAL APPLICATION

Hours per week: 6 (3 hr Lect/2 Hrs Tut/1 Hr Lab)

Credits: 18

Pre-requisite: None

Learning Outcomes:
On completion of this subject the student should be able to:-

1. Understand the fundamental techniques and applications of digital signal processing with emphasis on biomedical signals.
2. Implement algorithms based on discrete time signals.
3. Understand Circular and linear convolution and their implementation using DFT analyse signals using discrete Fourier transform.
4. Understand efficient computation techniques such as DIT and DIF FFT algorithms
5. Design FIR filters using window method, digital IIR filters by designing prototype analog filters and then applying analog to digital conversion.

Syllabus:

1. **Discrete time (DT) signals & systems**
   Review of Discrete time signals and systems
2. **Z Transform**
   Review of Z transform, Analysis of LTI system in Z domain
3. **Frequency Analysis of DT signal**
   DTFS definitions from orthogonal complex exponentials, CTFS & DTT and Properties of DTF, Power Density Spectrum, DTFT and Properties of DTFT, Energy Density Spectrum
   Relationship between DTFT & Z transform
4. **Discrete Fourier Transform (DFT)**
   DTFT, DFT and DFT properties, Block convolution using DFT by Overlap-add &
   Overlap-save methods, Fast Fourier Transform (FFT)
5. **System realization of DT Systems**
   System Transfer function, System realization using direct, cascade, parallel& Lattice forms.
   System Analysis: Impulse response, zero input and zero state response Signal generation.
6. **Design of Digital Filters:**
   Design of FIR filters, Design of IIR filters from analog filters, frequency transformations, Design of digital filters based on least squares method digital filters from analogue filters, properties of FIR digital filters. Design of FIR filters using windows, comparison of IIR and FIR filters and Linear phase filters.
7. **DSP Processors**
   Need for Special Architecture, Difference between DSP Processor & microprocessor, general DSP Processor

Text Books:

1. Ashok Ambadar, Analog and Digital Signal processing, Thomson Learning Publication, second edition first reprint, 2001.
2. Proakis and Manolakis, Digital Signal Processing Pearson
3. Oppenheim & Schafer with Buck, Discrete-Time Signal Processing. Pentice Hall, Signal Processing Series- second edition, 2000.
4. S.K. Mitra, digital Signal Processing, Tat McGraw Hill Publication.
5. T.J. Cavicchi, Digital Signal Processing, Wiley Publication, 2002.

Assessment:

Continuous assessment: **-50%**
Written examination: **-50% (1x3 hrs)**

AP 323: PHYSICAL ELECTRONICS

Hours per week: 6 (3 Hrs Lect/2 Hrs Tut/1 Lab)
Credits: 18,
Prerequisite: AP 262

Learning Objectives:

On completion of this subject the student should be able to:-

LO1. Explain basics of semiconductors.

LO2. Describe the Femi level in semiconductors.

LO3. Explain the different diode connections and their applications.

LO4. Apply the fundamental theory of transistors in different types of circuits.

LO5. Describe the theory of operational amplifiers and explain different circuits using OP AMPs.

LO6. Explain the functioning of different types of special devices.

Syllabus:

Basic idea of Quantum Physics and electrons in solids that is relevant to the physics of semiconductors. Energy of electrons in orbit. Classification of materials as conductors, semiconductors and insulators. Crystal structure of common semiconductors, Energy band model of semiconductors, Effective mass, hole concept, density of state function.
Basic ideas of electron statistics, Fermi level and Fermi function, Intrinsic and extrinsic semiconductors, Calculation of electron and hole densities and Fermi level in each case. Charge transport, drift, diffusion, and mobility. Formation of a barrier, contact potential, space charge region, biasing of a junction.
Current flow in a p-n junction. Derivation of Shockley diode equation. Junction rectifiers – Half wave and full wave rectifiers. Applications. Basic ideas of junction diode fabrication, alloying, diffusion, ion implantation, photoengraving.
Fundamentals of bipolar transistor operation, current flow in a typical device. Input output characteristics of bipolar transistors. Transistor biasingcircuits, CE amplifier, Oscillator circuits.

Textbook:

1. Seymour, J., Electronic Devices and Components, 2nd edition (Longman, 1988).
2. Simon M. Sze, Kwok K. Ng, Physics of Semiconductor Devices; 3rd Edition, Wiley, 2006.

Reference:

1. Sparkes, J.J., Semiconductor Devices (Van Nostrand Reinhold, 1987).
2. Bar Lev, A., Semiconductors and Electron Devices, 2nd edition (Prentice Hall, 1984).

Assessment:

Continuous assessment **- 50%**
Written examination. **- 50% (1 x 3 hrs)**

BE322: BIOMATERIALS I & II

Hours per week: 6 (3 hrs Lect/2Hrs Tut/ 1 hr Lab)

Credit: 18

Pre-requisite: AP 231.

Learning Outcomes:
On completion of this subject the student should be able to:-

1. Demonstrate the principles of electronics used in designing various diagnostic equipment.
2. Have in-depth knowledge about different streams in Biomedical Engineering with greater emphasis on health care equipments and the advanced technologies such as Telemedicine, Telemetry, Medical Imaging, etc.
3. Exhibit competency in suggesting, designing and offering the apt, reliable and optimum solution after understanding customer's requirement completely.
4. Demonstrate ability of correlating theoretical concepts with their practical implementation while performing laboratory exercises and project work.
5. Provide a better technical support with exposure to the hospitals and health care industry.
6. Use modern methodologies, multi-disciplinary skill set and knowledge while working on real time projects that demand convergence of engineering, science and technology.

Syllabus:

1. **Generation of Bioelectric Potentials:**
   Nerve, Muscle, Pacemaker and Cardiac muscle
2. **Biophysical signal capture, processing and recording systems (with technical specifications).**
   Typical medical recording system and general design consideration. Sources of noise in low level recording circuits. ECG, EMG, EEG, EOG, ERC. Phonocardiography. Measurement of skin resistance.
3. **Patient Monitoring System:**
   Measurement of Heart Rate, Pulse rate, Blood pressure, Temperature and Respiration rate, Apnea Detector.
4. **Arrhythmia and Ambulatory Monitoring Instruments:**
   Cardiac Arrhythmias. Ambulatory monitoring instruments.
5. **Foetal and Neonatal Monitoring System:**
   Cardiotocograph, Methods of monitoring of Foctal Heart rate and labrum activity, Foetal scalp PH measurement, Incubator and Infant warmer.
6. **Biotelemetry, Telemedicine concepts and its application**
7. **Biofeedback Technique: EEG, EMG**
8. **Electrical Safety in Biophysical Measurements**

Text Books:

1. Handbook of Biomedical Engineering By R.S. Khandpur, PHI
2. Medical Instrumentation, Application and Design By J.G. Webster, TMH.
3. Introduction to Biomedical Equipment Technology By Carr. Brown (Pearson Education Pub)
4. Introduction to Biomedical engineering by J Bronzino

References Books:

1. Encyclodedia of medical devices and instrumentation – J.G. Webster Vol I, II, II, IV (John Willey).
2. Various Instruments Manuals.
3. Principles of applied Biomedical Instrumentation by Geddes and Becker, Wiley interscience publication.
4. Principles of Biomedical Instrumentation and Measurement by Richard Aston

Assessment:

Continuous assessment	**-50%**
Written examination	**-50% (1x3 hrs)**

AP 323: PHYSICAL ELECTRONICS

Hours per week: 6 (3 Hrs Lect/2 Hrs Tut/1 Lab)
Credits: 18,
Prerequisite: AP 262

Learning Objectives:
On completion of this subject the student should be able to:-

LO1. Explain basics of semiconductors.

LO2. Describe the Femi level in semiconductors.

LO3. Explain the different diode connections and their applications.

LO4. Apply the fundamental theory of transistors in different types of circuits.

LO5. Describe the theory of operational amplifiers and explain different circuits using OP AMPs.

LO6. Explain the functioning of different types of special devices.

Syllabus:
Basic idea of Quantum Physics and electrons in solids that is relevant to the physics of semiconductors. Energy of electrons in orbit. Classification of materials as conductors, semiconductors and insulators. Crystal structure of common semiconductors, Energy band model of semiconductors, Effective mass, hole concept, density of state function.
Basic ideas of electron statistics, Fermi level and Fermi function, Intrinsic and extrinsic semiconductors, Calculation of electron and hole densities and Fermi level in each case. Charge transport, drift, diffusion, and mobility. Formation of a barrier, contact potential, space charge region, biasing of a junction.
Current flow in a p-n junction. Derivation of Shockley diode equation. Junction rectifiers – Half wave and full wave rectifiers. Applications. Basic ideas of junction diode fabrication, alloying, diffusion, ion implantation, photoengraving.
Fundamentals of bipolar transistor operation, current flow in a typical device. Input output characteristics of bipolar transistors. Transistor biasingcircuits, CE amplifier, Oscillator circuits.

Textbook:

3. Seymour, J., Electronic Devices and Components, 2nd edition (Longman, 1988).
4. Simon M. Sze, Kwok K. Ng, Physics of Semiconductor Devices; 3rd Edition, Wiley, 2006.

Reference:

3. Sparkes, J.J., Semiconductor Devices (Van Nostrand Reinhold, 1987).
4. Bar Lev, A., Semiconductors and Electron Devices, 2nd edition (Prentice Hall, 1984).

Assessment:
Continuous assessment **- 50%**
Written examination. **- 50% (1 x 3 hrs)**

AP 412: MODERN OPTICS AND LASERS

Hours per week: 6(3 Hrs Lect/2 Hr Tut/1 Hr Lab)
Credits: 18,

Prerequisite: AP 352

Learning Objectives:
On completion of this subject the student should be able to:-

LO1. Define and explain basic theories of optics.

LO2. Describe coherence and interference.

LO3. Describe the different diffraction patterns.

LO4. Evaluate the principle and theory of laser and to explain the different types of lasers.

LO5. Apply the theory of optical fibre in fibre optic communication.

LO6. Explain the principle of holography and its applications.

Syllabus:
Review of electromagnetic nature of light, basic theories of reflection, refraction, interference, diffraction and polarization, Total Internal Reflection, frustrated TIR.
Coherence and interference- Theory of partial coherence, coherence time and coherence length, coherence and line width, spatial coherence.
Diffraction- Fraunhofer and Fresnel diffraction, Fraunhofer and Fresnel diffraction patterns, high reflectance and antireflecting films.
Lasers – spontaneous emission, stimulated emission, Einstein coefficients, population inversion, Laser system, cavity configuration, mode structure and gain. Types of Lasers – Ruby laser, Nd^{3+} YAG laser, glass laser, He-Ne laser, Carbon dioxide laser, semiconductor laser, applications.
Fiber optics – Optical fiber, light propagation in step index fiber, numerical aperture, light propagation in graded index fiber, fiber losses, optical communication, sources and sensors.
Holography – Basic principle, recording of a hologram, reconstruction process, types of holograms, applications.

Textbook:
Guenther, R.D., Modern Optics (Wiley, 1990).

References:
Jones, K.A., Introduction to Optical Electronics (Harper and Row, 1987).
Watson, J., Optoelectronics (Van Nostrand Reinhold (UK) Co Ltd, 1988).
Fowles, G.R., Introduction to Modern Optics (Holt, Rinehard and Winston, 1968).

Assessment:
Continuous assessment **- 50%**
Written Examination **- 50% (1x3 hours)**

BE412: MEDICAL IMAGING I

Hours per week: 6(3 Hrs Lect/2 Hr Tut/1 Hr Lab)
Credits: 18,

Prerequisite: BE 311

Learning Objectives:
On completion of this subject the student should be able to:-

LO1. Define and explain the basic medical Imaging.

LO2. Describe various signals and types.

LO3. Describe the different diffraction patterns.

LO4. Evaluate the principles and theory of different equipment that deals with Medical Imaging.

LO5. Apply the theory of various medical Imaging methods used.

LO6. Explain the principle of medical imaging techniques.

Syllabus:
Ultrasound in Medicine, Production and Characteristics of Ultrasound. Display System: A-mode, B-mode and M-mode display and applications Ultrasound transducers and instrumentation. Real-Time Ultrasound, continuous wave Pulsed wave Doppler Ultrasound systems, color flow imaging, applications.X-ray Imaging,Properties of X-rays tubes, Rating of X-rays tubes, X-ray generators, -ray Images and Beam, Limiting Devices, Controls, X-ray Film development technique.
Fluoroscopy Imaging and X-ray Image intensifier
Computed Radiography and Digital Radiography
Angiography techniques, Mammography, Principle, Equipment, digital Mammography. Medical thermography: Physics of thermography, thermographle equipment, application.Endoscopy: Equipment, Imaging and its applications.

Text Books:
1. Christensen's Physics of diagnostic Radiology (Lipimcott William and Willkins Publication)
2. Medical Imaging Physics William R. Hendee (Wiley-Liss Publication)

Reference Books:
1. Biomedical Technology and Devices Handbook by James Moore, George Zouridakis (CRC Press)
2. Biomedical Engineering Handbook by Bronzino (CRC Press)
3. Physics of diagnostic Imaging – Dowsett

Assessment:
Continuous assessment **-50%**
Written examination **-50% (1x3 hrs)**

BE413: BIOMEDICAL INSTRUMENTATION II

Hours per week: 6(3 Hrs Lect/2 Hr Tut/1 Hr Lab)
Credits: 18,

Prerequisite: BE 311

Learning Objectives:
On completion of this subject the student should be able to:-

LO1. Define and explain the basic medical Imaging.

LO2. Describe various signals and types.

LO3. Describe the different diffraction patterns.

LO4. Evaluate the principles and theory of different equipment that deals with Medical Imaging.

LO5. Apply the theory of various medical Imaging methods used.

LO6. Explain the principle of medical imaging techniques.

Syllabus:

1. Foetal and Neonatal Monitoring System:
   Cardiotocograph, Methods of monitoring of Foctal Heart rate and labrum activity, Foetal scalp PH measurement, Incubator and Infant warmer.
2. Biotelemetry, Telemedicine concepts and its application
3. Biofeedback Technique: EEG, EMG
4. Electrical Safety in Biophysical Measurements
5. Physiotherapy, Electrotherapy and Radiation Therapy Instruments:
   Basic principle, working and technical specifications of Shortwave Diathermy, Ultrasonic therapy unit, Infrared and UV lamps, Nerve and Muscle Stimulator, Radiation and Physical Therapy Units.
6. Surgical Instruments: Surgical Diathermy machine, electrodes used with surgical diathermy, safety aspects in electronic surgical units, surgical diathermy analyzers.
7. Cardiac Pacemakers: Modes of operation, leads and electrodes. Power supply sources. External and Implantable Pacemaker, Performance aspects of Implantable Pacemaker.
8. Cardiac Defibrillators: DC defibrillator, Modes of operation and electrodes, Performance aspects of dc-defibrillator, defibrillator analyzers. Implantale defibrillator and defibrillator analyser.
9. Hemodialysis Machine: Basic principle of Dialysis. Different types of dialyzer membrane, Portable type.
11. Laser Applications in Biomedical Engineering: Laser Classifications, Types of Lasers, Medical Applications, Laser Delivery Systems.
12. Heart rate variability measurement and applications.

Text Books:
1. Handbook of Biomedical Instrumentation: R S, Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John wiley)
3. Handbook of Biomedical Engineering By R.S. Khandpur, PHI
4. Introduction to Biomedical Equipment Technology By Carr. Brown (Pearson Education Pub)
5. Introduction to Biomedical engineering by J Bronzino

Reference:
1. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol. I, II, III, IV (PH Pub)
2. Various Instruments Manuals
3. Principles of applied Biomedical Instrumentation by Geddes and Becker, Wiley interscience publication.
4. Principles of Biomedical Instrumentation and Measurement by Richard Aston

Assessment:

Continuous assessment	**-40%**
Written examination	**-60% (1x3 hrs)**

BE422: MEDICAL IMAGING II

Hours per week: 6(3 Hrs Lect/2 Hr Tut/1 Hr Lab)
Credits: 18,

Prerequisite: BE 412

Learning Objectives:

On completion of this subject the student should be able to:-

LO1. Define and explain the basic medical Imaging.

LO2. Describe various signals and types.

LO3. Describe the different diffraction patterns.

LO4. Evaluate the principles and theory of different equipment that deals with Medical Imaging.

LO5. Apply the theory of various medical Imaging methods used.

LO6. Explain the principle of medical imaging techniques.

Syllabus:
Computed Tomography. Principle of Computed Tomography 02, Scanner configurations/generations, CT system: Scanning unit (gantry), detectors, data acquisition system, spiral CT, scannerparameters, CT Number Reconstruction techniques, Radon Transform, Filtered Back projection, Fourier Reconstruction Technique, Iterative reconstruction Technique, Image quality and artifacts, Clinical applications of CT, Multi-detector computed tomography (MDCT), Flat panel detectors, CT-Angiography **01.**

Magnetic Resonance Imaging, Physics of MRI, Relaxation Parameters and Spin Echoes, Magnetic Field Gradients, Slice selection and Frequency, Encoding, Pulse sequences, Hardware: Magnets, Gradient systems, RF coils, **02**, Fourier Reconstruction techniques, Image contrast, Resolution and Factors affecting signal-to-noise, Safety Considerations/Biological Effects of MRI **02**

Magnetic Resonance Spectroscopy (MRS)
Basic Principle of MRS and localization techniques, Chemical Shift Imaging, Single-voxel and Multivoxel MRS, Water Suppression techniques
Basics of Electrical Impedance Tomography 02
Hybrid Imaging modalities and its clinical application

Text Books:
1. Christensen’s Physics of Diagnostic Radiology, Lipimcott William, (Willkins Publication)
2. Medical Imaging Physics William R. Hendee (Wiley-Liss Publication)

References:
1. Biomedical Technology and Devices Handbook by James Moore, George Zouridakis (CRC Press
2. Biomedical engineering Handbook by Bronzino (CRC Press)
3. Physics of Diagnostic Imaging – Dowsett

Assessment:
Continuous assessment **-50%**
Written examination **-50% (1x3 hrs)**

BE423: SENSORS AND ACTUATORS

Hours per week: 6(3 Hrs Lect/2 Hr Tut/1 Hr Lab)
Credits: 18,

Prerequisite: ??

Learning Objectives:
On completion of this subject the student should be able to:-
LO1. Understand various sensors, how they work, and different techniques to use them.
LO2. Understand the use and application of different motors.
LO3. Interface different sensors to a controller.
LO4. Develop programs in C for microcontrollers to control interfaced modules
LO5. Acquire the knowledge of basic serial communications, and be able to communicate between two processors.
LO6. Use a temperature chip to control the heat inside a system.
LO7. Control the speed of DC motors using microcontrollers.

Syllabus:
Programming microcontrollers in C, direct and modulated infra- red (IR) sensors, absolute and incremental encoders, quadrature encoders, strain gauge, bridge circuits, temperature sensors, Hall-effect sensors, interfacing different sensors to a controller and writing control programs in C, serial communication including wireless, using DC motor and controlling its speed with PWM in both directions, using stepper motors and servomotors.

Text Books:
Transducers for Biomedical Measurements: Principles and Applications. Richard S. C. Cobbold, John Wiley and Sons, 1984.

Assessment:

Continuous assessment **-50%**
Written examination **-50% (1x3 hrs)**

BE424: INSTALLATION, MAINTENANCE AND SERVICE

Hours per week: 6(3 Hrs Lect/2 Hr Tut/1 Hr Lab)
Credits: 18,

Prerequisite:

On completion of this subject the student should be able to:-
LO1. Understand various sensors, how they work, and different techniques to use them.
LO2. Understand the use and application of different motors.
LO3. Interface different sensors to a controller.
LO4. Develop programs in C for microcontrollers to control interfaced modules
LO5. Acquire the knowledge of basic serial communications, and be able to communicate between two processors.
LO6. Use a temperature chip to control the heat inside a system.
LO7. Control the speed of DC motors using microcontrollers.

Syllabus:
Importance of Biomedical engineering Department in the Hospital. Role of Biomedical Engineer in the hospital.
Various jobs carried out by Biomedical engineer in the industry such as – Sales and Marketing, Servicing and Maintenance, Research and development, Application Specialist.
Installation Techniques and/or methods: Pre-installation techniques. Precautions to be taken. Assembly of instrument/system. Testing of instrument before final handover.
Installation of medical equipments in various departments such as, Cardiac Equipments, O.T. equipments, Radiology equipments, Pathology equipments, Life- saving equipments, I.C.U., I.C.C.U., N.I.C.U. etc., Medical Gas.
Maintenance and Servicing. Preventive Maintenance and Calibration checks. Types of Maintenance contracts – CMC and AMC. Overall maintenance, Servicing and safety precautions of Medical and Non-medical equipments. Insurance of Medical Equipments.
Introduction to System operating protocol (SOP) for; ISO certification, NABH certification.

Text Books:
Manuals from different equipment's that are taught.

Assessment:
Continuous Assessment **-50%**
Written examination **-50% (1x3 hrs)**

BE425: INDUSTRIAL TRAINING

Hours per week: Required 12 weeks industrial training accumulated during the vacations of the BEBE course

Credits: 8

Prerequisite: After completion of 2nd year of BEBE program.

Learning Outcomes:
On completion of this subject the student should be able to:-

LO1. Ability to Explain and get familiar with aspects of industrial activities and facilities in PNG

LO2. Develop skills to work as a practical Applied Physicist;

LO3. Develop skills to write a detailed technical report.

Syllabus:
Training in industry. Perform a short practical project. Write a technical report on the project.

Assessment:
Continuous Assessment - **100%**

RELEVANT UNITECH POLICIES It is important that all students familiarize themselves with the University of Technology Assessment Guidelines including those on plagiarism which can be accessed at www.unitech.ac.pg/AssessmentGuide/ and www.unitech.ac.pg/Plagiarism