Course Title	**Practical Physics III**		
Course Code	PHY301G2		
Credit Value	02		
Hourly breakdown	Theory	Practical	Independent Learning
	-	90	10

Objectives

- Provide practical knowledge by applying experimental methods to correlate with the Physics theory
- Use various measurements related to modern physics, optics, electronics, mechanics and thermal physics
- Apply the analytical techniques and graphical analysis to experimental data
- Develop intellectual communication skills
- Demonstrate the interpersonal skills through seminar presentations

Intended Learning Outcomes

- Demonstrate conceptual understanding of fundamental physics principles
- Perform experiments in optics with spectrometer with diffraction gratings
- Analyse properties of gratings, emission spectra of certain elements produced by gas discharge tubes
- Investigate the thermal conductivity of poor thermal conductors using Lee's Disk
- Distinguish different mechanisms of heat transfer
- Construct circuits involving Owen's and Capacitance bridge
- Verify the concepts of material and modern physics
- Analyse different types of errors associated with scientific measurements
- Explain experimental outcomes in relation to existing physics theories
- Report the experimental results
- Disseminate knowledge through oral presentations

Course Contents

- **Optics**: Single slit diffraction, Oblique incidence in transmission grating, Hydrogen spectrum, Helium spectrum, Polarization by pile of plates. Laser diffraction, Dispersion and chromatic resolving power of prism, Cauchy's Equation, Application of Rayleigh's Criterion
- **AC Theory**: Owen's Bridge, Capacitance Bridge. Mutual Inductance, Coupled circuit
- **Mechanics and Waves**: Cantilever, Coupled oscillator, Kater's pendulum, Microwaves and Ultrasonic Waves
- **Modern Physics**: Radioactive Statistical Counting, Radioactive Decay, X-ray diffraction
- **Thermodynamics**: Temperature Coefficient, Thermo Generator, Specific Heat Capacity of a Liquid, Lee's Disc.

Oral Presentation:

- Students will be trained on preparing and making oral presentation on selected topic.

Teaching and Learning Methods

Presentation on experiments
Demonstration
Weekly notebook and lab report
Oral presentations

Assessment Strategy	
• Continuous assessment on practical classes, note-book, and lab reports	50 %
• Oral presentation during the course	10 %
• End of Semester Practical Examinations	40 %

Recommended References

- Loyd, D. H., Physics Laboratory Manual (3rd Edition), Thomson Higher Education, USA (2008)
- Garbovskiy, Y. A., Glushchenko, A. V., A Practical Guide to Experimental Geometrical Optics, Cambridge University Press (2017).
- Willson, J., D., Hernandez Hall, C. A., Physics Laboratory Experiments (8th Edition), Cengage Learning, USA (2015).
- James, J. F., An Introduction to Practical Laboratory Optics, Cambridge University Press (2014).

Course Title	Modern Physics		
Course Code	PHY302G3		
Credit Value	03		
Hourly breakdown	Theory	Practical	Independent Learning
	45	-	105

Objectives

- Introduce the basics of nuclear and particle physics
- Outline the inadequacy of classical physics and the need for modern theories
- Illustrate different types of atomic models
- Apply quantum concepts for studying atomic spectra

Intended Learning Outcomes

- Explain the constraints of Classical Mechanics
- Discuss the origin of energy quantization and quantum tunneling effects
- Solve the Schrödinger equation for a range of problems
- Discuss the evolution of atomic models
- Explain the atomic and nuclear properties applying quantum concepts
- Categorize different types of nuclear reactions

Course Contents

Quantum Physics:

Inadequacy of classical mechanics, Photo electric effect, Compton effect, wave particle duality, de Broglie wave, Heisenberg's uncertainly principle, Schrödinger wave equation, probability density, solution of simple time independent Schrödinger equations-the step potential and the potential well.

Atomic Physics:

Alpha particle scattering, Thomson atomic model, Bohr model of the Hydrogen atom, Rutherford model of the atom, estimation of the size of the nucleus, Bohr's theory and its limitations, Schrödinger equation for the hydrogen atom and its solution, the total, orbital, and magnetic quantum numbers, atomic spectra, Zeeman effect, fine structure of spectra and spin quantum number, many electron atoms, production and properties of X-rays.

Nuclear Physics:

Nuclear composition, mass and size of nucleus, nuclear forces, nuclear stability, radioactive transformation, liquid drop model of nuclei and its applications, nuclear reactions, nuclear fission and fusion, a brief introduction to elementary particles.

Teaching and Learning Methods

Lectures and tutorial discussions, e-learning, handouts, and guided learning

Assessment Strategy

In-Course Assessment	30 %
End of Course Examination	70 %

Recommended References

- Krane, K. S., Modern Physics (2nd edition), Wiley (1995)
- Taylor, J., Zafiratos, C., and Dubson, M. A., Modern Physics for Scientists and Engineers (2nd edition), Addison-Wesley (2003)
- French, A. P., and Taylor, E. F., Introduction to Quantum Physics (The MIT introductory physics series), W.W. Norton and Company (1978)

Course Title	**Thermal and Statistical Physics**		
Course Code	PHY303G3		
Credit Value	03		
Hourly breakdown	Theory	Practical	Independent Learning
	45	-	105

Objectives

- Discuss the laws of classical thermodynamics and formulations of statistical physics
- Apply principles of thermodynamics to simple thermal engines
- Make use of kinetic theory to understand the properties of materials

Intended Learning Outcomes

- Explain the first and second law of thermodynamics and their applications in calculating work done and entropies
- Estimate thermal efficiency of heat engines and coefficient of performance refrigerators
- Apply the derived Maxwell's relations to problems in thermodynamics
- Estimate changes in temperature of systems subjected to cooling
- Apply Planck's hypothesis to obtain the Stefan's law to analyze radiation emitted by a blackbody.
- Evaluate mean free path, coefficient of thermal conductivity, diffusion coefficient and coefficient of viscosity of a gas molecule.
- Adapt statistical theory for a gaseous system to estimate its velocities.

Course Contents

- **Thermodynamics:** Zeroth law and the concept of temperature, work, heat, internal energy and the first law of thermodynamics, second law of thermodynamics, Carnot's theorem, temperature, entropy, equation of state, Maxwell's thermodynamic relations and their application to simple systems, production and measurement of low temperatures, the third law of thermodynamics, heat engines
- **Thermal radiation:** The law of blackbody radiation, application of thermodynamics to blackbody radiation, radiation pyrometer
- **Kinetic theory:** Ideal gases, Van der Waal's gases, classical theory of specific heats of gases and solids, transport phenomena
- **Statistical physics:** Thermodynamic probability and its relation to entropy, Boltzmann distribution and its classical limit, partition functions, application to solid like assemblies and gaseous systems, Maxwell's distribution of velocities in gases

Teaching and Learning Methods

Lectures, tutorial discussions, e-learning, handouts and guided learning

Assessment Strategy

In-Course Assessment	30 %
End of Course Examination	70 %

Recommended References

- Zemansky, M. W., and Dittman, R. H., Heat and Thermodynamics (7th edition), McGraw Hill, New York (1997)
- Roy, B. N., Fundamentals of Classical and Statistical Thermodynamics (1st Edition), Wiley, New York (2002)
- Nag, P. K., Basic and Applied Thermodynamics, Tata McGraw Hill, India (2002)
- Moran, M. J., and Shapiro, H. N., Fundamentals of Engineering Thermodynamics (5th Edition), Wiley, New York (2006).

Course Title	**Medical Physics**			
Course Code	PHY304G2			
Credit Value	02			
Hourly breakdown	Theory	Practical	Independent Learning	
	25	15	60	

Objectives

- Discuss the principles of physics behind the operation of therapeutic and diagnostic medical equipment
- Explain the physical aspects of radiation dosimetry, treatment planning, dose calculations and distributions
- Identify safety, radiation protection principles and procedures

Intended Learning Outcomes

- Summarize the differences between ionizing and nonionizing radiations
- Explain the design of medical X-ray system and the parameters that influence image quality
- Explain most common modalities for our various types of imaging tests such as ultrasound scanner, PET scan and CT
- Apply key concepts specific to energy deposition in tissues
- Combine the dose related definitions in dose calculations

Course Contents

- **Radiation physics:** Review of atomic structure, characteristics of X- rays, photoelectric effect, Compton effect, pair production, nuclear decay, radioactivity, types of radiations, interaction of radiation with matter, radiation detection and radiation dosimetry.
- **Medical imaging physics:** Principles of image formation and quality, films and screens, digital imaging, image reconstruction with back projection, X- ray Computed Tomography (CT) and image processing, radiography (mammography and fluoroscopy), principles of Magnetic Resonance Imaging (MRI), mapping and applications, nuclear medicine imaging [Gamma camera, Single Photon Emission Computed Tomography (SPECT) and Positron Emission Tomography (PET)], principles and practice of ultrasound imaging.
- **Radiotherapy physics and radiation protection:** Medical transducers, standard equipment used in radiotherapy (linear accelerator and Cobalt teletherapy machine), basic physical aspects of photon and electron therapy, radiation treatment planning, dose calculations and distributions, radiation protection, safety considerations for patients and workers, quality assurance of medical devices.

Teaching and Learning Methods

Lectures, tutorial discussions, e-learning, handouts, guided learning and clinical visit.

Assessment Strategy

In-Course Assessment	20%
Report on clinical site visit	10 %
End of course examination	70 %

Recommended References

- Wolbarst, A. B., Physics of Radiology (2nd edition), Medical Physics Pub Corp (2005),
- Meredith, W.J. and Massey, J. B., Fundamental Physics of Radiology (3rd edition), Butterworth-Heinemann (1977)
- Podgorsak, E. P., Radiation Oncology Physics: A Handbook for Teachers and Students, Vienna, IAEA (2005)
- Webb, S., The Physics of Medical Imaging (1st Edition), Crc Press (1988).

Course Title	**Introduction to Astrophysics and Cosmology**		
Course Code	PHY305G2		
Credit Value	02		
Hourly breakdown	Theory	Practical	Independent Learning
	30	-	70

Objectives

- Recall the historical developments of astrophysics
- Demonstrate how the basic physical laws explain the properties and dynamics of astronomical objects and the Universe
- Explain the formation and properties of solar system, stars and galaxies
- Deliver knowledge of the origin and the evolution of the universe

Intended Learning Outcomes

- Explain the physics of telescopes including geometric optics
- Explain how astronomical distances are measured
- Apply the derived Kepler's Laws with Newton's laws and theorems to a range of astrophysical objects including extrasolar planets
- Explain the global properties and basic evolution of stars using the basic laws of physics
- Discuss the structure of the Milky Way
- Discuss the fundamental constituents of the Universe: baryons, dark matter and dark energy, and the observational evidence for their presence
- Explain the evolution of our Universe, including the evidence for the Big Bang
- Use the equations which describe the evolution of the Universe to derive properties of the Universe

Course Contents

The Universe and its physics:

- Historical background of astronomy, units in astronomy and observational measurement techniques, motions of heavenly bodies, celestial sphere and the atlas of stars, uses of optical instruments in astronomy and Doppler Effect.

Physics of Stars and galaxies:

- The origin of the solar system and extra-solar planets, moon and eclipses, terrestrial and Jovian planets, properties of the Sun.
- Formation and general properties of stars, measurement of basic stellar properties such as distance, luminosity, spectral classification, mass, density and radii, Stellar evolution and nucleo-synthesis, white dwarfs, neutron stars, black holes, structure of the milky way, other galaxies and their properties.

Cosmology:

- Olber's paradox, Hubble's Law; the age of the Universe; Evolution of the Universe: Madau diagram; Evidence for the Big Bang (blackbody radiation, nucleosynthesis); dark energy and the accelerating Universe.

Teaching and Learning Methods

Lectures, tutorial discussions, e-learning, handouts and guided learning

Assessment Strategy

In-course Assessments	30%
End of course examination	70%

Recommended References

- Carroll, B. W., and Ostlie, D. A., An Introduction to Modern Astrophysics (2nd edition), Addison-Wesley (2006)
- Dufay, J., Introduction to Astrophysics: The Stars (reissue edition), Dover Publications (2012)
- Ryden, B. and Peterson, B. M., Foundations of Astrophysics (1st edition), Addison-Wesley (2010)
  Maoz, D, Astrophysics in a Nutshell, 2nd edition (Princton University Press) (2016)

Course Title	**Basic Electricity and Electronics**		
Course Code	ELE301G3		
Credit Value	03		
Hourly breakdown	Theory	Practical	Independent Learning
	35	30	85

Objectives

- Recall the basics of simple electrical and electronic circuits
- Understand operation of semiconductor devices
- Construct single-stage amplifiers using Bipolar junction transistors (BJT) and field effect transistors (FET)
- Verify the theoretical concepts and simple circuits through laboratory experiments

Intended Learning Outcomes

- Analyse a linear electrical circuit using loop and node analysis, Thevenin's and Norton's theorem
- Explain the current-voltage behaviour of a capacitors and inductors connected to an 'ac' source
- Outline the working principle of p-n junction diodes and their applications
- Discuss the working principle of BJT, and JFET
- Analyse a small signal analysis of a BJT and FET amplifier using small signal models

Course Contents

Current electricity: Kirchhoff's Laws, nodal and loop analysis, bridges, Thevanin's and Norton's theorem, maximum power transfer theorem.

AC Theory: Introduction to alternating current, rms, average and peak-to peak values, AC capacitance and capacitive resistance, AC inductance and inductive resistance, frequency response of RC and LC circuits, resonance in RLC circuits.

Semiconductor Diodes and application: Semiconductor basics, origin of energy bands, types of semiconductors, p-n junctions; operation, forward and reverse biased p-n junction, avalanche and Zener breakdown, application of p-n junction diodes: half and full wave rectifier, smoothing and voltage regulation

Bipolar junction transistors: working principle of BJTs, transistor characteristics (input, transfer and output characteristics) transistor biasing, ac and dc load line, action of a BJT as a switch, action of a BJT as an amplifier, transistor amplifier design, small signal low frequency equivalent circuit models of BJT
Field effect transistors (FET): Types of FETs, working principle of JFET, characteristics of JFET, JFET amplifiers, small signal low-frequency equivalent circuit models of BJT. Introduction to MOSFETs.

Teaching and Learning Methods

In-person Lectures, tutorial discussions, e-learning, handouts, guided learning and practical sessions

Assessment Strategy

Practical	
Continuous Assessments of Practical Reports (15 %)	30 %
End of Course Practical Examination (15 %)	
Theory	
In-Course Assessment Examinations (20%)	70 %
End of Course Examination (50 %)	

Recommended References

- William H. Hayt, Jack Kemmerly, Steven M. Durbin, Engineering Circuit Analysis (8th edition), McGraw-Hill Education (2012)
- Jacob Millman, C. C. Haikias, Chetan D Parikh, Integrated Electronics: Analog and Digital Circuits and Systems (2nd Edition), McGraw-Hill Education (2009)
- Jacob Millman, Arvin Grabel, Microelectronics (2nd Edition), McGraw Hill India (2001)
- Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits, (6th edition), Oxford University Press

Course Title	**Analogue and Digital Electronics**		
Course Code	ELE302G3		
Credit Value	03		
Hourly breakdown	Theory	Practical	Independent Learning
	35	30	85

Objectives

- Understand the designing process of an integrated circuit
- Understand the working principle of differential and operational amplifier
- Design and construct electronic circuits using analogue and digital ICs.
- Discuss the basics of microprocessor and explore its applications

Intended Learning Outcomes

- Explain the evolution of integrated circuits
- Design and construct op amp-based circuits for analog computation
- Make use of logic gates, multiplexers and programmable gate arrays to construct combinational logic circuits
- Construct simple combinational and sequential electronic circuits
- Outline the architecture and application of microcontrollers and microprocessors

Course Contents

Integrated circuits: Evolution of integrated circuits, integrated circuit components and types, introduction to VLSI and semiconductor processing

Differential amplifiers: Operation of differential amplifiers, common and differential mode of operation, common mode rejection ratio

Operational amplifier: Introduction to operational amplifiers, IC 741, characteristics of ideal and non-ideal operational amplifiers, analogue electronic circuits with operational amplifiers (inverting and non-inverting amplifiers, voltage follower, current source, voltage source, filter, analogue computing circuits to perform addition, subtraction, differentiation, integration, exponentiation and logarithms)

Digital electronics: Logic gates, Boolean functions and operations, laws and rules of Boolean algebra, De-Morgan's theorem, introduction to TTL and CMOS logic, Boolean expressions and truth tables, Karnaugh maps, Combinational circuits: (adder, substractor, comparator, decoder, encoder, multiplexer, demultiplexer), Sequential circuits: flip-flops, registers, counters, State diagrams and tables, State minimization, and output realization

Introduction to microcontrollers and microprocessors: Microcontroller: Architecture, instruction set, I/O ports and peripherals, introduction to microcontrollers, basic computer architecture, introduction to CPU: ALU, CU and memory

Teaching and Learning Methods

In-person Lectures, tutorial discussions, e-learning, handouts, guided learning and practical sessions

Assessment Strategy

Practical	
Continues Assessment of Practical Reports (15 %)	30 %
End of Course Practical Examination (15 %)	
Theory	
In-Course Assessment Examinations (20 %)	70 %
End of Course Examination (50 %)	

Recommended References

- Roy Choudhury, D, Jain, B and Shail Jain, Linear Integrated Circuits (4th edition), New Age Publishers (2010)
- M. Morris Mano and Michael D. Ciletti, Digital Design with an Introduction to the Verilog HDL (5th edition), Pearson Education (2013)
- Thomas L. Floyd, David M. Buchla, Basic Operational Amplifiers and Linear Integrated Circuits (2nd edition), Prentice Hall (1999)
- Sergio Franco, Design with operational amplifiers and analog integrated circuits (3rd edition), Mc Graw Hill Education, (2014)