	MAHATMA GANDHI UNIVERSITY **Kottayam, Kerala** **Undergraduate Programmes (HONOURS)** **2025 Admission Onwards**

SYLLABUS			
SIGNATURE COURSE			
Name of the College	The Cochin College, Cochin		
Faculty/ Discipline	Physics		
Programme	BSc (Hons) Physics		
Course Coordinator	Vijeesh P		
Contributors	Dr. Vijeesh P, Dr. Anu Varghese		
Course Name	Biophysics & Physiological Systems		
Type of Course	DSE		
Specialization title	Medical Physics		
Course Code	MG3DSEPHYA02		
Course Level	200		
Course Summary	This course provides a rigorous analytical framework for understanding the physical mechanisms that sustain human life and the diagnostic technologies that monitor them. By integrating the principles of mechanics and thermodynamics with the study of physiological systems, students will evaluate the body as a complex machine—from the levers of the skeletal system to the fluid dynamics of blood circulation and the bioelectric propagation of nerve impulses. The curriculum further extends into optical biophysics and medical acoustics, equipping students with the essential quantitative tools to analyze sensory function, refractive correction, and the foundational physics behind clinical instruments like ECG, EEG, and ultrasonic imaging.		
Semester	3	**Credits**	4
Course Details	see below		
Pre-requisites, if any	Basic knowledge in various concepts in physics.		

Course Details

Learning Approach	**Lecture**	**Practical/Lab-P**	**Total Hours**
Credits	3	1	75

Course Outcomes (CO)

Number of COs		**6**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Analyse the mechanical and thermal stability of the human body by applying the principles of equilibrium, leverage, and heat transfer to physiological systems like skeletal muscles and core temperature regulation.	K, U, S	PO1, PO2, PO3
2	Evaluate the physics of fluid and wave motion to explain the energetics of blood circulation, the onset of turbulence in diseased arteries, and the clinical application of ultrasonic waves in diagnostic imaging.	K, U, S	PO1, PO2, PO3
3	Analyse the optical physics of the human eye by evaluating the mechanisms of accommodation, retinal thresholds, and the formation of images within the biological lens system.	U, A	PO1, PO2, PO3

Number of COs		6	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
4	Design corrective and enhancement strategies for human vision by applying the principles of refraction to treat defects like myopia and hyperopia, while assessing the utility of advanced optical tools such as telescope, microscope, confocal microscopy etc	U	PO1, PO2, PO3
5	Students will analyse the bioelectric mechanisms of the nervous system, specifically how neurons generate and propagate action potentials through electrochemical gradients. This foundation allows for the evaluation of diagnostic tools like ECGs and the design of sensory aids that interface directly with human neural circuitry.	U, An	PO1, PO2, PO3
6	Students will be able to experimentally validate the physical principles of mechanics, thermodynamics, and wave motion as they apply to human physiology by using medical and laboratory instrumentation to quantify biological variables such as skeletal torque, hemodynamic flow resistance, and ultrasonic wave propagation.	An, S	PO1, PO2, PO3

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

CO-PO Articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	3	3	-	-	-	-	-	-	-
CO 2	2	3	3	-	-	-	-	-	-	-
CO 3	2	3	3	-	-	-	-	-	-	-
CO 4	2	3	3	-	-	-	-	-	-	-
CO 5	2	3	3	-	-	-	-	-	-	-
CO 6	2	3	3	-	-	-	-	-	-	-

‘0’ is No Correlation, ‘1’ is Slight Correlation (Low level), ‘2’ is Moderate Correlation (Medium level) and ‘3’ is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Principles of Medical Physics: Mechanics, Thermodynamics, and Fluid Dynamics.			
	1.1	Equilibrium and stability, Equilibrium considerations for the human body, Stability of the human body under the action of an external force, Levers, Skeletal Muscles, the elbow, the hip, the back	4	["1"]
	1.2	Heat, temperature, temperature scales, transfer of heat: conduction, convection, radiation. Regulation of body temperature, Control of skin temperature	3	["1"]
	1.3	The Motion of Fluids: Bernoulli's equation, Viscosity and Poiseuille’s Law, Turbulent Flow, Circulation of blood, Energetics of blood flow, Turbulence in the blood, Arteriosclerosis and Blood Flow, Power produced by the heart, Measurement of Blood Pressure	4	["2"]
	1.4	Properties of sound, Hearing and the ear, frequency and pitch, intensity and loudness, Clinical uses of sound, Ultrasonic waves.	4	["2"]

Module	Units	Course Description	Hrs	CO No.
2	Biophysics of Vision and Optical Instrumentation.			
	2.1	Vision, Nature of light, Structure of the eye, Accommodation	4	["3"]
	2.2	Eye and the camera, Lens system of the eye, Retina, Threshold of vision	4	["3"]
	2.3	Defects in vision, Lens for myopia, lens for presbyopia and Hyperopia	4	["4"]
	2.4	Extension of vision, Telescope, microscope, confocal microscopy	3	["4"]
3	Bioelectricity and medical instrumentation			
	3.1	The Nervous system: The Neuron, Electrical Potentials in an axon, Action Potential, Propagation of the action potential, action potentials in muscles, axon circuit, synaptic transmission.	5	["5"]
	3.2	Diagnostic equipment: Electrocardio graph, Electroencephalo graph. Control systems, Feedback	5	["5"]
	3.3	Sensory Aids: Hearing Aids, Cochlear implant	5	["5"]
4	Practical			
	4.1	Centre of Mass and Stability: Determine the centre of mass of simple objects and relate it to the stability.(cuboid, cone etc)	3	["6"]
	4.2	Human Lever Systems: Use a force transducer/spring balance and weights to calculate the mechanical advantage and torque produced by the biceps (3rd-class lever) at different elbow angles.	3	["6"]
	4.3	Basal Metabolic Rate & Heat Loss: Measure the rate of cooling of a heated "phantom" (water-filled container) using conduction, convection, and radiation to simulate human thermoregulation.	3	["6"]
	4.4	Fluid Flow and Poiseuille’s Law: Use a variable-diameter tube system and a pressure gauge to demonstrate how radius changes (simulating arteriosclerosis) affect the flow rate and pressure of a viscous fluid.	3	["6"]
	4.5	Blood Pressure & Korotkoff Sounds: Use a sphygmomanometer and stethoscope to identify how turbulent flow creates the sounds used to determine systolic and diastolic pressure.	3	["6"]
	4.6	Pressure Measurement in Liquids: Use manometers to measure pressure at different depths in a liquid	3	["6"]
	4.7	Ultrasonic wave in Tissue/liquid: Use an ultrasonic transducer to measure the velocity of sound through different media (water, gelatine, or animal tissue) or to find thickness of materials, to understand diagnostic imaging basics.	3	["6"]
	4.8	Sound Transmission through Different Media: Investigate how sound intensity changes when transmitted through different materials (Use Physics Tool Box App or any other sound intensity meter to generate and detect sound)	3	["6"]
	4.9	Visualizing audio signals and measuring frequency using Audio Oscilloscope- Study each frequency at various intensity/loudness. Physics Tool box or any other suitable apps.	3	["6"]
	4.10	Study light illuminance with distance from a source using light meters (Physics tool Box or any similar apps)	3	["6"]

Teaching and Learning Approach	Classroom Procedure (Mode of transaction)
	Lecture, Demonstration, Tutorial, Simulations, Practical

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Both **A. Continuous Comprehensive Assessment (CCA)** • **Theory – 25 Marks** Quiz, Assignment, Seminar, Written Test • **Practical – 15 Marks** Lab involvement, Viva **B. End Semester Evaluation (ESE)** • **Theory – 50 Marks** Assessment Methods – short answer type questions, short essay type questions Duration of Examination – 1.50 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B Answer Type: ◦ PART - A ◦ Short answer - (10 out of 14) – 10 × 2 = 20 ◦ PART - B ◦ Short Essays - (6 out of 8) – 6 × 5 = 30 • **Practical – 35 Marks** Assessment Methods – Lab Exam, Record Duration of Examination – 2.00 Hrs

References

- 1. Davidovits, Paul. Physics in Biology and Medicine. 3rd Edition, Academic Press, 2008. 2. Arora, C. L., and S. L. Arora. Practical Physics for Undergraduate Students. S. Chand, 2012. 3. Davidovits, Paul. Physics in Biology and Medicine. 4th ed., Academic Press, 2014. 4. Glaser, Roland. Biophysics: An Introductory Approach. Springer, 2013.

Suggested Readings

- 1. Brown, B. H., Smallwood, R. H., Barber, D. C., Lawford, P. V., & Hose, D. R. Medical Physics and Biomedical Engineering. CRC Press. 2. Keevil, S. F., Padovani, R., Tabakov, S., et al. Introduction to Medical Physics. CRC Press. 3. Brown, S., Hooper, I., Pike, E. R., & Splinter, R. An Introduction to Biomedical Optics. Taylor & Francis. 4. Herman, Irving P. Physics of the Human Body. 2nd Edition, Springer. (Excellent for the Mechanics and Fluid Flow modules). 5. Hobbie, Russell K. & Roth, Bradley J. Intermediate Physics for Medicine and Biology. 5th Edition, Springer. (The definitive resource for Bioelectricity and Nerve Conduction).

Affidavit

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SYLLABUS			
SIGNATURE COURSE			
Name of the College	The Cochin College, Cochin		
Faculty/ Discipline	Physics		
Programme	BSc (Hons) Physics		
Course Coordinator	Vijeesh P		
Contributors	Dr.Jose Mathew		
Course Name	Computational Methods in Medical Physics		
Type of Course	DSE		
Specialization title	Medical Physics		
Course Code	MG4DSEPHYA02		
Course Level	200		
Course Summary	This course, Computational Methods in Medical Physics, introduces students to the use of computational tools and simulations to understand key medical physics concepts such as radiation behavior, including radioactive decay, inverse square law, and attenuation. It also covers digital image processing techniques like brightness adjustment, filtering, edge detection, and segmentation, along with basic concepts of X-ray and CT imaging and radiation safety. The course further introduces fundamental ideas of artificial intelligence, particularly the k-Nearest Neighbour (k-NN) method, for simple healthcare data classification. Through lectures and practical exercises using tools like Excel or Python, students gain hands-on experience in applying computational methods to solve problems in medical physics.		
Semester	4	**Credits**	4
Course Details			
Pre-requisites, if any	Basic Physics Chemistry and Mathematics - Higher Secondary Level		

Course Details:

Learning Approach	**Lecture**	**Practical/Lab-P**	**Total Hours**
Credits	3	1	75

Course Outcomes (CO)

Number of COs		**5**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Explain how computational methods and simulations are used to study medical physics concepts such as radiation, imaging, and safety without performing real experiments.	U	PO1, PO2
2	Apply basic numerical and graphical techniques using computers to simulate radioactive decay, inverse square law, and radiation attenuation.	U, A	PO1, PO2
3	Process and analyze digital images by performing brightness adjustment, filtering, edge detection, and simple segmentation using computer-based tools.	K, U, A	PO1, PO2

Number of COs		5	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
4	Demonstrate introductory data classification skills using a simple artificial intelligence method (k- Nearest Neighbour) and explain its relevance in healthcare applications. Demonstrating Imaging, Dose and AI in Data Analysis	K, U, A, S	PO1, PO2, PO3
5	To gain experience in applying numerical methods to a range of physical scenarios. And, to develop computational solutions for complex physics problems independently.	K, U, A	PO1, PO2, PO3

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

CO-PO Articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	1	-	-	-	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	-
CO 3	2	2	-	-	-	-	-	-	-	-
CO 4	2	2	3	-	-	-	-	-	-	-
CO 5	3	2	3	-	-	-	-	-	-	-

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Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Foundations of Computational Thinking			
	1.1	Computer applications in medical physics. Review of graphs and exponential behavior. Randomness in nature	3	["1"]
	1.2	Generating random numbers Plotting data and interpreting graphs	3	["1"]
	1.3	Radiation as an abstract concept (qualitative)	1	["2"]
	1.4	Radioactive decay as a probability process Half-life (coin-flip model) Inverse square law Attenuation and shielding (numerical) Half-life simulation using random numbers Intensity vs distance graphs Attenuation through layered materials (assumed coefficients)	8	["2"]

Module	Units	Course Description	Hrs	CO No.
2	Medical Images as Digital Data And introduction to AI in Medicine			
	2.1	Pixels and gray scale images Brightness and contrast Noise and smoothing Importance of image quality in diagnosis	5	["3"]
	2.2	Brightness and contrast adjustment Image blurring and sharpening Edge detection Threshold-based segmentation	7	["3"]
	2.3	What is Artificial Intelligence? Learning from examples Pattern recognition in healthcare. Ethical responsibility of AI in medicine	3	["4"]
	2.4	Simple k-Nearest Neighbour (k-NN) classification Classification of data as “normal / abnormal”	5	["4"]
3	Imaging & Dose (Conceptual)			
	3.1	Concept of X-ray imaging Idea of CT: projections → image What is radiation dose? Why dose must be minimized Distance and shielding as safety principles	4	["4"]
	3.2	Conceptual CT reconstruction (projection + back-projection) 2D dose map using distance + attenuation formula	6	["4"]
4	Practicals			
	4.1	Random Numbers Histogram Generate random numbers using Excel (=RAND()) or Python (numpy). Plot a histogram to visualize uniform distribution. Learn how randomness underlies radioactive decay.	3	["5"]
	4.2	Coin-Flip Half-Life Simulation Model radioactive decay by repeatedly halving a group of atoms using random coin flips. Plot how the number falls over steps.	3	["5"]
	4.3	Inverse-Square Law Simulation Make a table of distance vs. intensity (I ∝ 1/r2). Plot a graph to show how radiation weakens with distance.	3	["5"]
	4.4	Attenuation hrough materials Simulate X-ray intensity reduction through layers of water, bone, or lead using I = I0 * exp(-μx). Compare different materials.	3	["5"]
	4.5	Brightness and Contrast of an image Load a grayscale image (any photo or medical demo image). Adjust brightness and contrast using simple math operations.	3	["5"]
	4.6	Blur vs Sharpen Filter Apply a 3×3 average (blur) filter and a sharpening filter to an image. Compare before and after.	3	["5"]
	4.7	Edge Detection Use a Sobel filter (Excel kernel or Python OpenCV) to detect edges in an image. Highlight boundaries of objects/organs.	3	["5"]
	4.8	Threshold Segmentation Pick a brightness threshold and separate regions of an image (e.g., highlight tumor-like bright spots).	3	["5"]
	4.9	Simple CT Reconstruction Simulate CT by taking projections of a phantom image and reconstructing it using Radon transform (concept demo).	3	["5"]
	4.10	k-Nearest Neighbors Classification Create a small dataset of colored points (two classes). Use k-NN to classify a new point. Relates to AI in medical imaging.	3	["5"]

Teaching and Learning Approach	Classroom Procedure (Mode of transaction)
	Lectures, Demonstrations, Animations, Presentations, Discussions, Programming sessions

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Both **A. Continuous Comprehensive Assessment (CCA)** • **Theory – 25 Marks** Quiz, Assignment, Seminar • **Practical – 15 Marks** Lab involvement, Viva **B. End Semester Evaluation (ESE)** • **Theory – 50 Marks** Assessment Methods – short answer type questions, short essay type questions Duration of Examination – 1.50 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B Answer Type: ∘ PART - A ∘ Short answer - (10 out of 14) – 10 × 2 = 20 ∘ PART - B ∘ Short Essays/Problems - (6 out of 8) – 6 × 5 = 30 • **Practical – 35 Marks** Assessment Methods – Lab Exam, Record Duration of Examination – 2.00 Hrs

References

- Gonzalez, R. C. & Woods, R. E. Digital Image Processing, Pearson Education (Introductory chapters: pixels, grayscale images, filtering, edges)
- Harish Chandra Verma Concepts of Physics, Volume 2 Publisher: Bharati Bhawan (Introductory Concepts of nuclear decay)
- Downey, A. B. Think Python: How to Think Like a Computer Scientist O'Reilly Media (Basic programming and computational thinking)

Suggested Readings

- Hendee, W. R. & Ritenour, E. R. Medical Imaging Physics, Wiley (Conceptual understanding of imaging and dose)
- Attix, F. H. Introduction to Radiological Physics and Radiation Dosimetry, Wiley (Qualitative reference for radiation and safety concepts)
- Bushberg, J. T., Seibert, J. A., Leidholdt, E. M., Boone, J. M. The Essential Physics of Medical Imaging, Lippincott Williams & Wilkins (Conceptual background only)
- Giordano, N. J. & Nakanishi, H. Computational Physics, Pearson (Introductory ideas on simulation and numerical thinking)

Affidavit

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MAHATMA GANDHI UNIVERSITY
Kottayam, Kerala

Undergraduate Programmes (HONOURS)
2025 Admission Onwards

SYLLABUS			
SIGNATURE COURSE			
Name of the College	The Cochin College, Cochin		
Faculty/ Discipline	Physics		
Programme	BSc (Hons) Physics		
Course Coordinator	Vijeesh P		
Contributors	Dr Manjusha, Dr Sharon VS		
Course Name	Radiation Physics		
Type of Course	DSE		
Specialization title	Medical Physics		
Course Code	MG5DSEPHYA02		
Course Level	300		
Course Summary	The course in “Radiation Physics” provides a comprehensive foundation in radiation physics, covering atomic and nuclear structure, radioactivity, and sources of natural and artificial radiation. It explains the interaction of radiation with matter, principles of radiation detection, and measurement techniques including dosimetry and detector systems. The course also introduces biological effects of radiation, dose–response relationships, and medical applications in diagnosis and therapy. It further emphasizes radiation protection principles, safety standards, monitoring methods, and regulatory concepts to ensure safe use of radiation in scientific and medical fields.		
Semester	5	**Credits**	4
Course Details			
Pre-requisites, if any			

Course Details:

Learning Approach	Lecture	Practical/Lab-P	Total Hours
Credits	3	1	75

Course Outcomes (CO)

Number of COs		**6**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Students will be able to understand the concepts of fundamentals of atomic and nuclear structure	K, U	PO1, PO2, PO3
2	Students will be able to explain the sources and production of radiation	U	PO1, PO2, PO3
3	Students will be able to understand and explain the interaction of photons, charged particles, and neutrons with matter	U	PO1, PO2, PO3
4	Students will be able to understand the working principles and applications of radiation detectors and dosimetry systems, and explain radiation quantities, dose limits, and basic calibration concepts relevant to radiation protection.	U, A	PO1, PO2, PO3

Number of COs		6	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
5	Students will be able to understand the biological effects of radiation, distinguish between deterministic and stochastic effects, explain the principles of medical applications of radiation in diagnosis and therapy, and describe radiation protection principles and regulatory frameworks.	U, A	PO1, PO2, PO3
6	Students will be able to perform radiation detection and measurement experiments using a GM counter, analyze counting statistics and detector characteristics, estimate detector efficiency, measure radiation intensity, shielding effectiveness and background radiation, and simulate radioactive decay, inverse square law, and radiation attenuation using Python.	K, U, A	PO1, PO2, PO3

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

CO-PO Articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	3	-	-	-	-	-	-	-
CO 2	2	3	3	-	-	-	-	-	-	-
CO 3	1	3	3	-	-	-	-	-	-	-
CO 4	2	3	3	-	-	-	-	-	-	-
CO 5	1	3	2	-	-	-	-	-	-	-
CO 6	1	3	3	-	-	-	-	-	-	-

‘0’ is No Correlation, ‘1’ is Slight Correlation (Low level), ‘2’ is Moderate Correlation (Medium level) and ‘3’ is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Fundamentals & Sources of Radiation			
	1.1	Structure of Matter Atomic structure: atom, atomic number (Z), mass number (A)Nuclear structure and stability, Atomic mass, energy units, binding energy, mass defect, Orbital electrons and atomic energy levels, Nuclear forces and nuclear energy levels, Electromagnetic radiation and particle radiation (introductory)	5	["1"]
	1.2	Radioactivity & Nuclear Transformations Natural and artificial radioactivity, Law of radioactive decay, Decay constant, activity, units (Bq), Half-life and mean life, Radioactive series, Radioactive equilibrium, Modes of decay: alpha, beta, gamma, internal conversion, Basic nuclear reactions and energy release (Q-value)	5	["1"]
	1.3	Sources of Radiation & X-ray Production Natural radiation sources (cosmic, terrestrial, internal), Artificial radiation sources (reactors, accelerators, isotopes)	2	["2"]
	1.4	Principles of X-ray production, Characteristic X-rays, X-ray tube construction and working, Factors affecting X-ray spectrum and intensity, Applications in medical and industrial fields (overview)	3	["2"]

Module	Units	Course Description	Hrs	CO No.
2	Interaction, Detection & Dosimetry			
	2.1	Interaction of Radiation with Matter Photon interactions with matter: Coherent scattering – elastic scattering without energy loss,Photoelectric effect – dominant at low energies, depends strongly on atomic number,Compton scattering – dominant in soft tissue at diagnostic/therapy energies,Pair production – occurs when photon energy > 1.02 MeV Energy & atomic number dependence: Probability of interaction vs photon energy,Mass attenuation coefficient Charged particle interactions: Ionization and excitation,Stopping power,Range of electrons and heavy charged particles Attenuation concepts: Linear attenuation coefficient,Half Value Layer (HVL),Tenth Value Layer (TVL)	5	["3"]
	2.2	Radiation Detection & Measurement Principles of radiation detection: Ionization processes in gases,Signal formation Gas-filled detectors: Ionization chamber – dose measurement standard,Proportional counter – pulse proportional to energy,Geiger–Müller counter – radiation survey instrument Solid-state detectors: Semiconductor detectors (Si, Ge),Energy resolution Scintillation detectors: Light emission principle,Photomultiplier tube, Detector characteristics: Sensitivity, Efficiency, Dead time, Energy dependence	5	["4"]
	2.3	Radiation Dosimetry Dosimetric quantities: Exposure, Absorbed dose, Kerma, Equivalent dose, Effective dose Absolute dosimetry: Ionization chamber calibration, Standard laboratory concepts, gel dosimetry Relative dosimetry: Film dosimetry, Thermoluminescent dosimeters (TLD),Optically stimulated luminescence (OSL) Radiation monitoring: Personnel monitoring devices, Protection basics	5	["4"]
3	Biological Effects, Applications & Protection			
	3.1	Radiation Protection Principles : Background radiation and natural sources, dose equivalent and effective dose equivalent , Occupational and public dose limits,ALARA principle (As Low As Reasonably Achievable),Radiation monitoring and safety standards	5	["5"]
	3.2	Applications of Radiation in Medicine: Medical imaging and diagnostic radiology,Radiation therapy applications,Nuclear medicine basics,Patient dose considerations	3	["5"]
	3.3	Radiation Safety & Protection Practices: Background radiation and natural sources, dose equivalent and effective dose equivalent, Occupational and public dose limits, ALARA principle (As Low As Reasonably Achievable), Radiation monitoring and safety standards. Shielding and protective devices, Leak testing of radioactive sources, Personnel monitoring, Radiation protection surveys	7	["5"]

Module	Units	Course Description	Hrs	CO No.
4	PRACTICAL			
	4.1	GM Counter- Inverse square law properties	3	["6"]
	4.2	GM Counter- Statistics of counting	3	["6"]
	4.3	GM Counter- Study of the characteristics a GM tube and determination of its operating voltage, plateau length /slope etc	3	["6"]
	4.4	Estimation of efficiency of the GM detector for (a) Gamma source (b) Beta source	3	["6"]
	4.5	Measurement of shielding effectiveness of various materials of differen thickness	3	["6"]
	4.6	Measurement of background radiation at a place	3	["6"]
	4.7	Demonstrating Cumulative Radiation Dose Measurement with a Personal Dosimeter	3	["6"]
	4.8	Radioactive Decay Simulation using python	3	["6"]
	4.9	Inverse Square Law Simulation of radiation using Python	3	["6"]
	4.10	Linear Attenuation Coefficient: Demonstration of attenuation of radiation while passing through a material, using Python	3	["6"]

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Demonstration, Tutorial, Simulations, Practical

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Both **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 25 Marks** Quiz, Assignments, Seminar,Written tests **• Practical – 15 Marks** Lab involvement, Viva **B. End Semester Evaluation (ESE)** **• Theory – 50 Marks** Assessment Methods – Written tests Duration of Examination – 1.50 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B Answer Type: ∘ PART - A ∘ Short answer - (10 out of 14) – 10 × 2 = 20 ∘ PART - B ∘ Short Essays - (6 out of 8) – 6 × 5 = 30 **• Practical – 35 Marks** Assessment Methods – Lab Exam, Record: Duration of Examination – 2.00 Hrs

References

- 1. Khan, F. M. The Physics of Radiation Therapy. Lippincott Williams & Wilkins. 2. Hall, E. J., & Giaccia, A. J. Radiobiology for the Radiologist. Lippincott. 3. Podgorsak, E. B. Radiation Physics for Medical Physicists. Springer. 4. Cherry, S. R., Sorenson, J. A., & Phelps, M. E. Physics in Nuclear Medicine. Saunders. 5. Martin, A., & Harbison, S. An Introduction to Radiation

Protection. CRC Press.

Suggested Readings

- 1. Kase, K. R., Krauss, R. H., & Tsoulfanidis, N. — Radiation Detection and Measurement (Wiley) — Classic on detectors & measurement techniques. 2. Attix, F. H. — Introduction to Radiological Physics and Radiation Dosimetry (Wiley-Interscience) — Fundamental treatment of dosimetry principles. 3. Shultis, J. K., & Faw, R. E. — Radiation Shielding (American Nuclear Society) — Comprehensive on shielding theory and practice. 4. McParland, B. J., & Nahum, A. E. (Eds.) — Comprehensive Biomedical Physics (Elsevier) — Multidisciplinary overview including radiation physics topics. 5. Zaidi, H., & Hasegawa, B. H. (Eds.) — Quantitative Analysis in Nuclear Medicine Imaging (Springer) — Reference for quantitative imaging and detector physics

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	MAHATMA GANDHI UNIVERSITY **Kottayam, Kerala** **Undergraduate Programmes (HONOURS)** **2025 Admission Onwards**

<table>
<tr><th colspan="4">SYLLABUS</th></tr>
<tr><th colspan="4">SIGNATURE COURSE</th></tr>
<tr><td>Name of the College</td><td colspan="3">The Cochin College, Cochin</td></tr>
<tr><td>Faculty/ Discipline</td><td colspan="3">Physics</td></tr>
<tr><td>Programme</td><td colspan="3">BSc (Hons) Physics</td></tr>
<tr><td>Course Coordinator</td><td colspan="3">Vijeesh P</td></tr>
<tr><td>Contributors</td><td colspan="3">Dr Uma S, Dr Sathya Narayanan K</td></tr>
<tr><td>Course Name</td><td colspan="3">Basics of Medical Devices and Imaging</td></tr>
<tr><td>Type of Course</td><td colspan="3">DSE</td></tr>
<tr><td>Specialization title</td><td colspan="3">Medical Physics</td></tr>
<tr><td>Course Code</td><td colspan="3">MG6DSEPHYA02</td></tr>
<tr><td>Course Level</td><td colspan="3">300</td></tr>
<tr><td>Course Summary</td><td colspan="3">This course introduces the physical principles behind common medical devices and modern diagnostic imaging systems. It covers basic measurements such as pressure, temperature, sound intensity, and frequency, and explains how they are used in devices like sphygmomanometers, infusion pumps, spirometers, thermometers, stethoscopes, pulse oximeters, ECG, EEG, glucometers, and defibrillators. The course also explores major medical imaging technologies—X-ray, CT, ultrasound, MRI, and nuclear medicine (PET/SPECT)—focusing on image formation, instrumentation, clinical applications, and safety.</td></tr>
<tr><td>Semester</td><td>6</td><td>Credits</td><td>4</td></tr>
<tr><td>Course Details</td><td colspan="3"><table><tr><th>Learning Approach</th><th>Lecture</th><th>Total Hours</th></tr><tr><td>Credits</td><td>4</td><td>60</td></tr></table></td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="3">Basic Physics</td></tr>
</table>

Course Outcomes (CO)

<table>
<tr><th colspan="2">Number of COs</th><th colspan="2">5</th></tr>
<tr><th>CO No.</th><th>Expected Course Outcome</th><th>Learning Domains *</th><th>PO No</th></tr>
<tr><td>1</td><td>Students will be able to understand the measurement principles of pressure, temperature, sound, and frequency used in medical instrumentation.</td><td>K, U, I</td><td>PO1, PO2, PO3</td></tr>
<tr><td>2</td><td>Explain the working principles and clinical purpose of common devices such as sphygmomanometer, spirometer, nebulizer, infusion pump, thermometer, stethoscope, pulse oximeter, ECG, EEG, glucometer, and defibrillator.</td><td>K, U, A, I</td><td>PO1, PO2, PO3</td></tr>
<tr><td>3</td><td>Trace the historical development and describe major medical imaging techniques like X Ray Scan, CT Scan, Ultra Sound Scan, MRI etc</td><td>K, U, A, An, E, I, S</td><td>PO1, PO2, PO3</td></tr>
<tr><td>4</td><td>Explain the principles of nuclear medicine imaging using radioactive tracers, PET, SPECT, and gamma cameras.</td><td>K, U, A, An, E, I, S</td><td>PO1, PO2, PO3</td></tr>
</table>

Number of COs		5	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
5	Relate physiological parameters to the physical signals detected and processed by medical devices.	K, U, A, An, I	PO1, PO2, PO3

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

CO-PO Articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	3	-	-	-	-	-	-	-
CO 2	2	3	2	-	-	-	-	-	-	-
CO 3	1	3	3	-	-	-	-	-	-	-
CO 4	2	2	2	-	-	-	-	-	-	-
CO 5	2	2	2	-	-	-	-	-	-	-

‘0’ is No Correlation, ‘1’ is Slight Correlation (Low level), ‘2’ is Moderate Correlation (Medium level) and ‘3’ is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Physics of Medical devices			
	1.1	Measurement Principles used in Common Medical Devices - pressure, temperature, sound intensity, frequency	3	["1"]
	1.2	Sphygmomanometer, infusion pump, Spirometer, Nebulizer	4	["2"]
	1.3	Clinical thermometers, stethoscope, Pulse Oximeter	4	["2"]
	1.4	ECG, EEG, Glucometer, Defibrillator	4	["2"]
2	Imaging Modalities – X-ray, CT, and Ultrasound			
	2.1	History and evolution of medical imaging, imaging types: X-ray, CT, Ultrasound	3	["3"]
	2.2	X-Ray Imaging: X-ray tube, attenuation, radiographs, safety	4	["3"]
	2.3	CT Scanning: Spiral CT, cross-sectional imaging, contrast agents	4	["3"]
	2.4	Ultrasound: Sound waves, reflection, transducers, Doppler, safety	4	["3"]
3	MRI and Nuclear Medicine			
	3.1	MRI: Magnetic fields, hydrogen atoms, RF pulses, image contrast (T1/T2), applications, safety	7	["3"]
	3.2	Nuclear Medicine: Radioactive tracers, PET, SPECT, gamma cameras, applications in diagnosis and therapy.	8	["4"]

Module	Units	Course Description	Hrs	CO No.
4	Demonstration Activity			
	4.1	Light Absorption through Colored Solutions (Beer–Lambert Law) - Use red/IR LED and LDR to measure absorption, Principle behind Pulse oximeter.	3	["5"]
	4.2	Brain Wave Demonstration Videos + Signal Filtering Activity - Use recorded datasets to understand filtering, Principle of Electroencephalograph.	3	["5"]
	4.3	DIY ECG Principle using Electrodes + Arduino / Vernier (simulation) - Record small electrical variations from muscle movement, Concept of Electrocardiograph.	3	["5"]
	4.4	CT Scan Principle using Object Slices - Take shadow images of an object from multiple angles and reconstruct, Demonstrates idea of Computed Tomography (CT).	3	["5"]
	4.5	NMR Analogy using Bar Magnets and Iron Filings - Show alignment in magnetic field, Concept behind Magnetic Resonance Imaging (MRI).	3	["5"]

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Leverage a blended learning approach with a mix of lectures, interactive discussions, and Demonstration sessions

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Theory **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 30 Marks** Quiz, Assignments, Seminar,Written tests **B. End Semester Evaluation (ESE)** **• Theory – 70 Marks** Assessment Methods – Written tests Duration of Examination – 2.00 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B , C Answer Type: ◦ PART - A ◦ Short answer - (10 out of 12) – 10 × 3 = 30 ◦ PART - B ◦ Short Essays - (4 out of 6) – 4 × 7 = 28 ◦ PART - C ◦ Essays - (1 out of 2) – 1 × 12 = 12

References

- 1. The Essential Physics of Medical Imaging - 4th edition by Jerrold T. Bushberg, J. Anthony Seibert PhD, Edwin M. Leidholdt Jr. PhD, John M. Boone 2. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeffer — Biomedical Instrumentation & Measurements 3. William Hendee & E. Russell Ritenour — Medical Imaging Physics

Suggested Readings

- 1. John G. Webster (Ed.) — Medical Instrumentation: Application and Design 2. R. S. Khandpur — Handbook of Biomedical Instrumentation 3. Fundamentals of Biomedical Engineering — G. S. Sawhney 4. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications – N. Barrie Smith & A. Webb

Affidavit

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