Department of Biomedical Physics and Technology

Faculty of Science, University of Dhaka

Syllabus

Programs: Master of Philosophy (M.Phil.) and Doctor of Philosophy (Ph.D.)

Effective from the academic session **2024-2025**. This curriculum will continue until changes are brought about later.

Introduction to the Department

The Department of Biomedical Physics and Technology is a post graduate multidisciplinary department under the Faculty of Science of the University of Dhaka established in 2008. This department emphasizes research and development aimed at delivering the benefits of modern healthcare technology to the common people. This department aims high to make itself one of the centerpieces in the area of Biomedical Physics, Engineering and Technology.

Introduction to the Program

This is a multidisciplinary department taking in postgraduate students from various disciplines in science, engineering and medicine, and therefore a student taking admission into a Ph.D. or M.Phil program has to obtain some working background on necessary related subjects not covered by his/her previous background. These courses are designed not to make a student expert in all these subjects, but to give him/her an overview together with some fundamental concepts so that during the course of research s/he can feel the relevance of a particular topic of a particular subject and refer to an expert.

Details of the syllabus

A combined list of the courses presently offered and their code names are given below (**BMPT** stands for **B**io**m**edical **P**hysics and **T**echnology; course code starting digit **6** indicates the Ph.D. & M**.**Phil. programs).

Course code	Course title	Marks
BMPT 601	Human Body in Health and Disease	100
BMPT 602	Biomedical Instrumentation	100
BMPT 603	Radiation Physics and Imaging Methods	100
BMPT 604	Research Methodology	100

To comply with uniform requirement of the University of Dhaka, Ph.D. and M.Phil. students of this department will have taught courses equivalent to 2 full units of 60 contact hours each. The present syllabus contains 04 (four) full unit courses (each of 60 contact hours), and a student has to take 02 (two) of these courses, based on his/her background and as suggested by his/her supervisor.

BMPT 601 Human Body in Health and Disease	01 unit	Contact hours: 60

Introduction to the body: Levels of organization, Anatomical position, anatomical directions, planes of the body, Cavities, Body regions. (3)

Balance of body function: Homeostasis, Feedback Control, Negative feedback, Positive feedback, Healthy fluctuations. (3)

Human cell: Basic organizations, Constituents, nucleus and chromosomes, Cell membrane, Membrane transport, organelles, Cell cycle and cell division. (3)

Tissues: Tissue types, Epithelial tissue, Connective tissue, Muscle tissue, Nervous tissue. (3)

Skeletal system: Bones and cartilage's, types, characters situations, functions and Joints. (2)

Muscular System: Classification, characteristic, function and structure. (2)

Blood: Composition, Plasma protein, Formed elements of blood. (2)

Cardiovascular System: Physiology of cardiac muscle. Conductive system of heart. Cardiac cycles, ECG, Cardiac output and venous return, Blood pressure and its regulation physics of blood, blood flow and pressure. (5)

Respiratory system: Respiratory apparatus, Pulmonary ventilation, Mechanism of respiration, Lung function tests, Gaseous exchange, oxy-haemoglobin and carbondioxide dissociation curve. Regulation of respiration, Hypoxia. (4)

Renal physiology and body fluid: Physiology of kidneys. Mechanism of urine formation kidney function tests. Body fluid types, compartments, measurement, compositions. Body matter and mater balance oedima and pulmonary fluid, the special fluid system of the body. (4)

Alimentary system: Introduction, Transport of food, Digestive juices composition, secretion function. Bile, Structure and function of liver. Liver function tests. (3)

Nervous system: Organization, Neurons, Nerve, Fibres, Synapse, Neuro transmitters, Sensory system of the body motor system of the body. Sensory and motor pathways of spiral cord. Function of cerebellum, Basal ganglia and Hypothalamus. Physiology of Autonomic Nervous system. (5)

Special Senses: Optics of Visions, Physiology. Errors of retraction. Accommodation and light ratlines- and auditory pathway. Physiology as smell and taste. (3)

Endocrinology and Reproduction: Types, general mechanism of action, function and secretion of hormone. Physiology of pregnancy, foetus and neonate. (3)

Mechanisms of Disease: Viruses, Bacteria, Fungi, Protozoa, mechanism of transmission. (3)
Tumors and cancer: Neoplasms, cause of cancer, Classification, Characteristic features of benign and malignant tumours. Grading and staging of malignant tumours. Precancerous conditions. Various methods for diagnosis of cancer. (5)

Cell Injury: Reversible and irreversible injury, cellular swelling and fatty change, necrosis and its types, Gangrene. (3)

Inflammation: Vascular changes, exudate formation, types, features of acute inflammation, Granular formation, Definition of Healing, repair, regeneration. Factors influencing healing. (4)

Recommended Books:

1. The Human Body in Health & Disease, Kevin T. Patton, Frank B. Bell, Terry Thompson, Peggie L. Williamson, Elsevier Health Sciences, 8th edition, 2023.

2. Human Anatomy & Physiology. Elaine N. Marieb, Katja N. Hoehn. Pearson. 9th Edition.
3. Textbook of Medical Physiology. Guyton and Hall. Elsevier. 14th Edition
4. Ganong's Review of Medical Physiology. Kim E Barrett, Susan M Barman, Jason Yuan, Heddwen L Brooks. McGraw Hill Medical; 26th edition.

BMPT 602 Biomedical Instrumentation 01 unit Contact hours: 60

Generation and recording of Bio potentials: Origin and propagation of bio-signals, Electrode electrolyte interface, electrode–skin interface, half-cell potential. Types of electrodes, biomaterial used for electrode designing, characteristics of bio-signals. Recording of ECG, EMG, EOG and EEG signals. (9)

Amplifier characteristics: Need for bio-amplifier, single and differential bio-amplifier. Filtering, isolation amplifiers and optical isolation- isolated DC and AC amplifier, chopper amplifier and power line interference. (8)

Electrocardiography measurement: Origin of ECG, Electronic amplifiers (source impedance, gain, frequency response), 3 lead, Einthoven's triangle, Twelve lead configuration and measurements. (4)

Electro-physiological measurement: EEG, voluntary EMG, Evoked responses, Motor & Sensory Nerve conduction velocity measurement, Signal averaging, Visual & Audio evoked responses (SVR, BSER), Otto-Acoustic Emission (6)

Temperature measurement and monitoring: Mercury clinical maximum recording thermometer, electronic thermometer, Infrared Radiation measurement, Infrared Camera (3)

Blood pressure measurement: Indirect (non-invasive: basis, Sphygmomanometer, mercury & electronic), Direct (invasive) (3)

Respiratory measurements: Different types of Flow sensors, Spirometric functions, measurement and analysis. (3)

Plethysmography: Optical, Electrical Impedance (3)

Ultrasound Doppler techniques: Blood velocity measurement, Foetal monitoring. (2)

Therapy and Rehabilitation: Cardiac Defibrillator, Artificial Pacemaker, Hearing aids, Vision correction, Functional Electrical Stimulation (FES). (6)

Physiotherapy instruments: Infra-red heating, RF diathermy, Ultrasound therapy, Muscle & Nerve stimulators. (4)

Computers in medicine: Data acquisition, storage and analysis, Patient monitoring systems, Telemedicine. (4)

Patient safety: Electrical and patient safety, medical devices classification and their safety standards, different types of safety circuits for medical equipment and measures to reduce shock hazards. (5)

Recommended Books:

1. Medical Physics by John R. Cameron, John Wiley & Sons, Inc.
2. Medical Physics and Biomedical Engineering (Medical Science Series) by B.H Brown,R.H Smallwood, D.C. Barber, and P.V Lawford, D.R Hose, CRC press, 2017.
3. Biomedical Instrumentation: Technology and Applications by R. S. Khandpur, McGrawHill
4. Biomedical Transducers and Instruments by Tatsuo Togawa, Toshiyo Tamura, and P.A. Öberg, CRC Press Inc

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BMPT 603 Radiation Physics and Imaging Methods 01 unit Contact hours: 60

Radioactive decay: decay law, modes of radioactive decay, Activity, half-life, decay constant, radioactive equilibrium. (3)

Interaction of radiation with matter and absorption of radiation: Coherent scattering, Photoelectric interaction, Compton scattering, Pair production, Pair annihilation, Linear and Mass attenuation coefficient, exponential law, half value layer. (5)

Interaction of charged particles with matter: Stopping power, Specific ionization, Linear energy transfer. (3)

Radiation measurement: Dose measurement units, absorbed dose vs KERMA, gas filled detector, scintillation detector, semiconductor detector, thermoluminescent dosimeter (TLD), film badge. (5)

Biological effects of radiation exposure: Chemical changes, Change in molecular level. Direct and indirect action of damage, stochastic and deterministic effects. (3)

Radiation protection: Principle, Basic radiation protection criteria, justification, optimization, dose limits, ALARA principle, rules for operation of a radiation laboratory, external radiation protection, and internal radiation protection, workload use factor, occupancy factor, shielding calculation. (5)

Radiation imaging technologies: X-rays, CT scanner, image reconstruction, dual energy CT, positron emission tomography (PET), Gamma camera, single photon emission computed tomography (SPECT) (8)

Radiation therapy: Principle of radiation therapy, implementing radiation therapy treatment planning, evaluation, and delivery, Simulator, teletherapy, Co-60 unit, Linac, brachytherapy. (7)

Ultrasound imaging: nature and properties of Ultrasound, ultrasound transducer, A, B and M Scan, Doppler imaging, Elastography (5)

Magnetic Resonance Imaging (MRI): The nuclear magnetic moment, Precession in the presence of a magnetic field, T1 and T2 relaxations, saturation recovery pulse sequence, spin–echo pulse sequence, Localization: gradients and slice selection, Frequency and phase encoding, FID and resolution, Imaging and multiple slicing, Magnetic resonance spectroscopy. (6)

Electrical localization and Imaging: Tetrapolar Impedance Measurement (TPIM), Focused Impedance Method (FIM) – 6 electrode and 4 electrode, Pigeon Hole Imaging (PHI) and Electrical Impedance Tomography (EIT) (5)

Emerging techniques: Elastography, Diffuse optical tomography, Optical coherence tomography, Tactile imaging, Magnetoencephalography, Photoacoustic imaging. (5)

Recommended Books:

1. Radiation Physics for Medical Physicists, Ervin B. Podgorsak, Springer, 2016
2. The Physics of Radiation Therapy, Faiz M. Khan, John P. Gibbons, Lippincott Williams & Wilkins. 5th edition, 2014
3. Introduction to Radiological Physics and Radiation Dosimetry, Frank H. Attix, John Wiley & Sons.
4. The Essential Physics of Medical Imaging by J T Bushberg, J A Seibert, E M. Leidholdt Jr, J M Boone.
5. Medical Physics and Biomedical Engineering by B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose. CRC Press, 2017.

BMPT 604 Research Methodology	**01 unit**	**Contact hours: 60**

Introduction: Definition, objectives, and significance, Types of research: basic, applied, experimental, theoretical. Characteristics of good research. (4)

Research Problem Identification: Problem statement and hypothesis, Qualities of a good Hypothesis, Null Hypothesis & Alternative Hypothesis, Research questions and objectives, Literature review strategies and tools, sources of information, assessment of quality of journals and articles. (6)

Research Design: Exploratory, descriptive, analytical, experimental; Concept of variables: independent, dependent, controlled; Qualitative and Quantitative Research, Data types, collection methods, Surveys, case studies, interviews, simulations; Measurement and Instrumentation: Validity, reliability, calibration; Experimental setup. (10)

Sampling: Concepts of Statistical Population, Sample, Sampling frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample, Practical considerations in sampling and sample size. (12)

Data Analysis: Data Preparation, Deterministic and random data, Uncertainty analysis, Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis: Cross tabulations, Tests for significance: Chisquare, student's t-test, Regression modeling, Direct and Interaction effects, ANOVA, F-test, Time Series analysis. (12)

Research Communication: Scientific writing, Structure of research papers and reports, Writing abstracts, introductions, methodology, results, and discussion, Reference management tools. Peer Review and Publishing Process, Understanding peer review, Predatory journal. (10)

Research Ethics: Research Ethics and Integrity, Plagiarism, self-plagiarism, fabrication, falsification, Ethical approval processes, Data privacy and consent, Intellectual Property Rights (IPR), Patents, copyrights. (6)

Recommended Books:

1. Engineering Research Methodology: A Practical Insight for Researchers, Dipankar Deb, Rajeeb Dey, Valentina E. Balas, Springer, 2019
2. Research Methods for Engineers, David V. Thiel, Cambridge University Press, 2014
3. Research Methodology, C.R. Kothari, Gaurav Garg, New Age International Publishers; Fourth edition, 2019