বায়োমেডিকেল ফিজিক্স এন্ড টেকনোলজি বিভাগ
ঢাকা বিশ্ববিদ্যালয়
ঢাকা- ১০০০
বাংলাদেশ

Department of Biomedical Physics & Technology
Dhaka University
Dhaka – 1000, Bangladesh

Ref: BMPT/Syllabus/MS/2014-15
25.11.2015

Course Outline (As revised at Academic Committee meeting on 25.11.2015)

Degree: MS in Biomedical Physics & Technology

with two specializations:

i) Medical Physics

ii) Biomedical Engineering

Duration of course: 1 year
Effective from academic session 2014-15. This syllabus will continue until changes are brought about later.

Explanation: 4 Credits: 60 lectures; 3 Credits: 45 lectures; 2 Credits: 30 lectures

Entry requirements:

i) **For specialization in Medical Physics:** BS in Physics, Applied Physics, Medical Physics and related subjects.

ii) **For specialization in Biomedical Engineering:** BS in Physics, Applied Physics, Electronics, Medical Physics, Electrical & Electronic Engineering, Biomedical Engineering and related subjects.

Course requirements:
A student has to take 32 credits by choosing from the following courses to get an M.S. degree in Biomedical Physics & Technology.

A. Mandatory courses for all students:		**Credits**
BPT-M_01.	Human Body in Health & Disease	4
BPT-M_02.	Biophysics	3
BPT-M_03.	Biomedical Instrumentation	4
BPT-M_04.	Medical Imaging Methods and Nuclear Medicine	4
Sub-Total A:		**15**

Tel: 880-2-9661900 Ext 7011, Fax: 880-2-9667222, web: <www.bmpt.du.ac.bd>, email: bmpt@du.ac.bd

B. Optional courses for specialization in Medical Physics (15 credits to be taken)

BPT-M_11.	Radiation Biology & Oncology Physics	4
BPT-M_12.	Radiation Dosimetry, Shielding & Protection	3
BPT-M_13.	Radiotherapy equipment & Treatment Planning	4
BPT-M_20.	Internship	4
Sub-Total B:		**15**

C. Optional courses for specialization in Biomedical Engineering (15 credits to be taken)

BPT-M_21.	Bioelectricity, Bioimpedance & Biophotonics	3
BPT-M_22.	Computers & Microcontrollers in Medical Devices	2
BPT-M_23.	Biomedical Signal Processing	3
BPT-M_29.	Practical laboratory work	3
BPT-M_30.	Thesis	4
Sub-Total C:		**15**

D. Other Mandatory items

BPT-M_31.	Viva-voce	2
Sub-Total D:		2
Grand TOTAL:		**32**

Degree: MS in Biomedical Physics & Technology

with two specialisations:

iii) Medical Physics

iv) Biomedical Engineering

Syllabus details

(As revised at Academic Committee meeting on 25.11.2015)

Duration of course: 1 year

This syllabus will take effect from the academic session 2014-15, and will continue until changes are brought about later.

Explanation: 4 Credits: 60 lectures; 3 Credits: 45 lectures; 2 Credits: 30 lectures

Entry requirements:

iii) **For specialisation in Medical Physics:** BS in Physics, Applied Physics, Medical Physics and related subjects.

iv) **For specialisation in Biomedical Engineering:** BS in Physics, Applied Physics, Electronics, Medical Physics, Electrical & Electronic Engineering, Computer Science & Engineering, Biomedical Engineering and related subjects.

Course requirements:

A student has to take 32 credits by choosing from the following courses to get an M.S. degree in Biomedical Physics & Technology.

A. Mandatory Courses

(16 credits)

(starts from BPT-M_01)

BPT-M_01. Human Body in Health & Disease **4 credits**

1. Introduction to the human body: structural levels of human body; the internal environment and homeostasis. (2h)
2. Introduction to the chemistry of life (I): atoms, molecules and compounds; important biological molecules. (2h)
3. Introduction to the chemistry of life (II): Movements of substances within the body; body fluids. (1h)
4. Human Cell: Plasma membrane, organelles, cell division, mutation (2h)
5. Human Cell: Transport of substances across biological membranes (3h)

6. Cell surface specialization and junctional complexes. (1h)
7. Epithelial tissue: Definition, Classification, Components, Characters, Distribution and function. (2h)
8. Nervous tissue: Definition, Classification, Components, Characters, Distribution and function. (3h)
9. Connective tissue and Muscular tissue: Definition, classification, components, Characters, Distribution and function. (2h)
10. Disorders of cells and tissues (I): Introduction to the pathophysiology and cellular adaptation concept, concepts of etiology and pathogenesis, morphology and functional changes of tissues (2h)
11. Disorders of cells and tissues (II): Basic concepts of cellular injury and adaptation, inflammation, infract and shock, thrombosis and embolism. (2h)
12. Disorders of cells and tissues (III): Neoplasm and tumours; characteristic feature of benign and malignant tumours, grading and staging of malignant tumours; precancerous conditions, various methods of diagnosis of cancer. (3h)
13. Skeletal system: Bones and cartilage, types, characteristics; location, function; joints. (2h)
14. Muscular System: Classification, characteristics, function and structure. (1h)
15. Blood: Composition, Plasma protein, Formed elements of blood. (3h)
16. Cardiovascular System: Component, parts, heart and blood vessels, General, Portal and Regional circulation, lymphatic drainage. Physiology of cardiac muscle. Conductive system of heart. Cardiac cycles, ECG, Cardiac output and venous return, Blood pressure and its regulation, physics of blood flow and pressure. (4h)
17. Respiratory system: Respiratory apparatus, Pulmonary ventilation, Mechanism of respiration, Lung function tests, Gaseous exchange, oxy-heamoglobin and carbon-di-oxide dissociation curve; Regulation of respiration, Hypoxia. (4h)
18. Urinary System: General outline of Uro-Genital Component parts, situation, structure, Physiology of kidneys. Mechanism of urine formation kidney function tests, Oedema and pulmonary fluid, the special fluid system of the body. (3h)
19. Digestive system: Introduction, A general outline of its different parts with their functions. Digestive glands and associated organs; Transport of food, Digestive juices- composition, secretion function; Bile, Structure and function of liver; Liver function tests. (4h)
20. Nervous system: A general outline of organization, Neurons, Nerve, Fibers, Synapse, Neuro transmitters, Sensory system of the body motor system of the body; Sensory and motor pathways of spinal cord; Function of cerebellum, Basal ganglia and Hypothalamus; Physiology of Autonomic Nervous system. (5h)
21. Special Senses: Optics of Visions, Physiology; Errors of refraction; Accommodation and light reflex, auditory pathway; Physiology of smell and taste. (2h)
22. Endocrinology and Reproduction: Types, general mechanism of action, function and secretion of hormone; Clinical importance of endocrine system; Physiology of pregnancy. (3h)
23. The skin: Structure of the skin, function of the skin; wound healing. (1h)
24. Surface Anatomy of the whole body and its organs (3h)

BPT-M_02. Biophysics **3 credits**

1. Structure of Macromolecules: Atomic and Molecular forces, Behaviour of macromolecules, Physics techniques of structure determination (e.g. X-ray diffraction, Spectroscopy, and NMR). (4h)
2. Protein structures: Amino acids, primary, secondary and tertiary structures. (2h)
3. Properties and Structure of Nucleic Acid: DNA, RNA, Viruses, Methods of replication. (3h)
4. Basic Enzyme Behaviour: Michaelis Menten mechanism and MWC model. (2h)
5. Neural communication: Basic membrane properties, Diffusion and transport, Chemical pump and membrane potential, action potentials of nerves and muscles, equivalent dipole and volume conductor fields, electrical model of a nerve fibre, generation and propagation of action potential – polarisation, depolarisation and repolarisation, conduction velocity, conduction in myelinated nerve fibres, neurotransmitter, muscle action potential, muscle contraction mechanism, muscle activity for movement, major disorders of the neuromuscular system and their effects on conduction – nerve block, demyelination, neural degeneration, muscular degeneration. (12h)
6. Sensory Organs: Eye (vision)- focusing and adaptation, disorders. Ear – ear canal resonance, sound transmission and amplification through ossicles, Cochlear function, Otoacoustic Emission, Hearing threshold in terms of Sound pressure level (SPL) and Hearing threshold level (HTL), hearing defects in terms of HTL. (6h)
7. Cardiovascular system: Pumping action of heart and blood flow cycle, Natural pacemakers of the heart – SA node, AV node, HP-bundle; mechanism of pacemaker cells in creating oscillations, ECG, properties of blood, valves, arterial and venous system, blood pressure and blood flow in vessels, distributed venous pump, work done by the heart. (7h)
8. Lungs and Respiration: Mechanism of breathing in terms of pressure creation by body, Pressure and Volume related functions of lungs during tidal breathing and forced manoeuvres, the same in lungs with disorders, airway resistance. (5h)
9. Bio-Mechanics: structure, function and mechanical properties of biological tissues. (4h)

Recommended Books:

1. W.T. Hughes, Aspects of Biophysics, John Wiley and Sons.
2. B.H. Brown and R.H. Smallwood, Medical Physics and Physiological Measurements, Black-well Scientific Publications.
3. J.R. Cameron and J.G. Skofronick, Medical Physics, John Wiley and Sons.
4. Irving P. Herman, Physics of Human Body, Springer.

BPT-M_03. Biomedical Instrumentation **4 credits**

A. For Diagnosis

1. Thermal sensors and measuring circuits: thermocouple, thermistor, Infrared radiation based thermometers. (4h)
2. Optical sensors: photoconductors (LDR), photodiodes, phototransistors; spectral response considerations, basic measuring circuits. Instrumentation: Optical Plethysmography, Pulse Oximetry. (4h)

3. Sound sensors and measurements: Stethoscope, frequency response considerations. (2h)
4. Flow, velocity and movement measurement: electromagnetic blood flow sensor, Ultrasound Doppler blood velocity sensor & Instrumentation (non-directional), Ultrasound Doppler Foetal monitor. (6h)
5. Bioelectrical measurements: Surface and needle Electrodes, electrode-equivalent circuits, Noise & CMRR considerations, Instrumentation (Bioelectric) amplifier, Gain and frequency response considerations. (6h)
6. Electrocardiography: Twelve lead configuration and front end network, Signal amplitude and frequency content, Vectorcardiography (5h)
7. EMG Instrumentation and measurement (2h)
8. EEG Instrumentation and measurement (2h)
9. Evoked response measurement, signal averaging, artificial stimulation of nerves, Sensory & Motor Nerve conduction velocity measurement, Visual & Audio evoked responses (SVR, BSER) (7h)
10. Blood pressure measurement: Indirect (non-invasive: basis, Sphygmomanometer, mercury & electronic), Direct (invasive) (3h)
11. Respiration measurements: Peak flow meter, Spirometer, Electrical impedance measurement. (3h)
12. Patient monitoring systems (1h)
13. Telemedicine basic concepts (2h)
14. Patient Safety and regulatory issues. (1h)

B. For Therapy and Rehabilitation:

1. In cardiac disorders: Defibrillator, Pacemaker (2h)
2. In hearing defects: Hearing aids, Cochlear Implants (2h)
3. Physiotherapy instruments: Infra-red heating, RF diathermy, Ultrasound therapy, Muscle & Nerve stimulators. (4h)

C. For In -Vitro Measurements:

1. Colorimeter, Spectrophotometer, Conductometer, pH-meter (4h)

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, Churchill Livingstone
3. Biomedical Instrumentation: Technology and Applications by R. S. Khandpur, McGraw-Hill
4. Biomedical Transducers and Instruments by Tatsuo Togawa, Toshiyo Tamura, and P.A. Öberg, CRC Press Inc.

BPT-M_04. Medical Imaging methods & Nuclear Medicine **4 credits**

1. Introduction to medical imaging (1h)

   The role of Physics in medical imaging and the range of imaging methods.

2. Ultrasound Imaging (10h)

   Transducers, properties of ultrasound beam, interaction of the beam with the patient, acoustic impedance, scanning modes (A, B and M Scan), Doppler ultrasound and flow imaging (Colour Doppler).

3. X-ray imaging and X-ray CT (12h)

   X-ray tubes and generation of X-rays, X-ray spectrum, interaction of X-rays with the patient, attenuation, image receptors, X-ray image properties, measurement noise, contrast, resolution, Mammography and Fluoroscopy.

   X-ray computed tomography (CT), 2-D and 3-D imaging, filtered back projection, Hounsfield Units.

4. Introduction to image reconstruction and image processing:

   (8h)

   Digital image representation, Fourier reconstruction methods, iterative reconstruction, modulation transfer functions, 2D convolution, image filtering and noise reduction, image segmentation, image registration, Visualization software.

5. Magnetic Resonance Imaging (MRI) (8h)

   Basic concepts of MR Physics, spin polarization, resonance, relaxation, spin echoes, gradient echoes, spatial encoding using magnetic field gradients, k-space and image reconstruction, relaxation enhancement. Clinical utility of MRI. Introductory functional MRI, MR spectroscopy, chemical shift.

6. Other imaging modalities in medical research (8h)

   Magnetoencephalography, electrical impedance tomography, electroencephalography, high frequency ultrasound, diffuse optical tomography, optical coherence tomography.

7. Nuclear Medicine: (13h)

   Radioisotopes, radiotracers and molecular imaging, radiopharmaceuticals and their supply, scintillators, gamma cameras, resolution, sensitivity, collimators, rectilinear scanners, SPECT, PET. Artificial production of radio-nuclides for Nuclear Medicine, Applications in brain tumour detection, Iodine uptake by Thyroid gland, Bone scan, etc.

B. FOR SPECIALIZATION IN MEDICAL PHYSICS

OPTIONAL COURSES (15 credits)
Starts from BPT-M_11

BPT-M_11. Radiation Biology & Oncology Physics — 4 credits

1. Basic cell physiology and function, Physiological mechanisms for defects, repair, maintenance, and growth.
2. Ionizing radiations and their properties, Effects of ionizing radiation on biological materials: from molecular interactions, through sub-cellular and cellular levels of organization, with special relevance to oncology. Cell Cycle (LET, OER, SF, RBE), Sensitizers to Radiation-induced damage.
3. Somatic effects of radiation: Physical factors influencing somatic effects, Dependence on dose, dose rate, type of energy of radiation, temperature, anoxia; Acute radiation sickness, Effect of chronic exposure to radiation, Radiation carcinogenesis, Risk of carcinogenesis, In-utero exposure; Genetic effects of radiation: Factors affecting frequency of radiation induced mutations; Aspects of environmental radiation exposure, stochastic & deterministic effects of radiation.
4. Biological basis of radiotherapy: Physical and biological factors affecting cell survival, tumour re-growth and normal tissue response, non-conventional fractionation scheme and their effect of re-oxygenation, repair, redistribution in the cell cycle, High LET radiation therapy.
5. Time dose fractionation, basis for dose fractionation in beam therapy, concept of nominal standard dose (NSD), Roentgen equivalent therapy (RET), Time dose fractionation (TDF) factors and cumulative radiation effects (CRE), Gap correction.,
6. Radiobiological Models, Linear and Linear quadratic models.
7. Image based anatomy relevant to Radiotherapy (especially on CT images used in treatment planning), relevant physiology and pathology. Correlation of anatomical structures.

BPT-M_12. Radiation Dosimetry, Shielding & Protection — 3 credits

1. Radioactive decay and kinetics of radioactive decay, production of ionizing radiation, particularly of those used in radiotherapy.
2. Radiation detection: gas, scintillation, and solid state radiation detectors, Photomultiplier tubes, counting statistics.
3. Radiation dose units and quantities: Particle flux and fluence, energy flux, fluence cross-section, Linear and mass attenuation coefficients, mass-energy transfer and mass energy absorption coefficients, stopping power, LET, Absorbed dose, Kerma, Exposure, Dose equivalent, Effective dose.

4. External radiation hazards, effects of distance, time and shielding, personnel and area monitoring, internal radiation hazards, radio toxicity of different radionuclides, contamination, control of contamination, mitigation of external and internal radiation hazards, ICRP dose system, ICRP dose criteria. radiation protection principles during radiological emergency.
5. Personal monitoring devices, individual dose index, weighting factor of different types of radiation, Tissue weighting factors, Effective dose, dose limits for occupational workers, public, during pregnancy.
6. Safety in the medical uses of radiation: Planning of medical radiation installations, general considerations, design of diagnostic, deep therapy, telegamma, and accelerator installations, brachytherapy facilities, and medical radioisotope laboratories. Shielding calculation for radiology, radiotherapy and nuclear medicine facilities.
7. Radiation protection during transportation of radioactive materials, Radioactive waste disposal.
8. Safety and regulatory requirements, brief history of accidents of radiotherapy, responsibilities of medical physicists and radiation safety officers.

BPT-M_13. Radiotherapy equipment & Treatment Planning **4 credits**

1. Radiation sources, inverse square law, penetration, treatment parameters, Central Axis and Off –axis doses, Percent Depth Dose, Iso-dose distributions, tissue compensation, Volume definition.
2. Dosimetry in Radiotherapy procedures: dose calculations for photon and electron beams, Calibration. Absorbed dose.
3. Therapeutic X-Ray (production, properties, beam quality, machines)
4. Therapeutic Gamma Ray (Cobalt Sources, properties, housing, dose delivery, collimation & effects)
5. Particle Accelerators – LINACS (photon and electron beams)
6. Commissioning and Quality Assurance
7. IGRT, Stereotactic ablative radiotherapy, IMRT, VMAT, Gamma knife, Cyber knife, Intraoperative radiotherapy
8. Brachytherapy – LDR and HDR brachytherapy
9. Therapy using Protons, Neutrons and heavy ions (brief introduction)
10. Computational techniques in radiotherapy.
11. System configuration, software and algorithms (2D to 3D),
12. Beam modifiers – for photons and for electrons, Heterogeneity corrections.
13. Image display and dose volume histograms.
14. Optimization. Record and verify (RV) systems.
15. Biological modelling. Patient treatment position & immobilization devices.

16. Data acquisition and entry. Machine data. Beam data and entry.
17. Patient data. Treatment Simulation, Phantom measurements.
18. Treatment time and Monitor Unit calculation.
19. Quality Assurance in Treatment Planning, Regulations

BPT-M_20. Internship **4 Credits**

C. FOR SPECIALIZATION IN BIOMEDICAL ENGINEERING

OPTIONAL COURSES (15 credits)
Starts from BPT-M_21

BPT-M_21. Bioelectricity, Bioimpedance & Biophotonics **3 credits**

A. Bioelectricity (13h)

1. Origin of Bioelectricity, Semi-permeable membranes and ion channels, charge separation by membranes, charge pumps, Membrane potential, Nernst equation, nerve and muscle action potentials, The Hodgkin–Huxley Membrane Model. (4h)
2. Modelling volume conductor and volume source, Theory of Bioelectric Measurements, Lead field equations, Reciprocal lead field, Sensitivity field. (4h)
3. Dielectrics, polarization, DC and AC polarization, relaxation, complex permittivity and conductivity. (2h)
4. Electrical model and properties of cells in the body, cell membrane, intracellular and extracellular fluid, effect of external electric fields with dc and ac of different frequencies, various dispersion ranges. (3h)

B. Bioimpedance (18h)

5. Theory of measurement of Bioimpedance: electrodes, electrode-electrolyte interface; dc and ac models; two, three and four electrode measurements; isocurrent and isopotentials, sensitivity distribution, negative sensitivity; infinite and bound mediums, concepts of Finite Element Method for numerical solutions. (5h)
6. Bioimpedance at different frequencies, Electrical equivalent circuit, Cole model, complex impedance, Cole-Cole plot. (2h)
7. Practical measurement of Bioimpedance: Basic electronic circuitry, noise considerations and sensitivity, Multi-frequency measurements. (3h)
8. Physiological effects of dc and ac on body tissues, leakage current, safety issues in measurements. (2h)
9. Electrical Impedance Tomography (EIT): basics for 2D EIT, 3D effects. (2h)
10. Focused Impedance Method (FIM): 8, 6 and 4 electrode methods; equipotential models, sensitivity distributions; (3h)
11. Clinical applications of bioimpedance. (1h)

C. Biophotonics (14h)

12. Optical properties of tissue: fundamental optical properties of tissue - refraction, scattering, absorption, light transport in various tissues, Light-Tissue Interactions and Photobiology. (4h)
13. Lasers in medicine: Principles of laser, Laser Tweezer and Laser scissors, Application of laser in medicine: surgery, dermatology, ophthalmology, otolaryngology, laser angioplasty, laser safety, cervical ablation. (6h)
14. Bioimaging: Principles and Techniques (2h)
15. Biophotonic diagnosis and therapy: basic concepts. (2h)

Recommended Books:

1. J. Malmivuo and R. Plonsey Bioelectromagnetism, Principles and Applications of Bioelectric and Biomagnetic Fields, Oxford University Press, 1995
2. S. Grimnes and O.G. Martinsen, Bioimpedance and Bioelectricity Basics, Academic Press, 2000, ISBN: 0-19-505823-2
3. J.G.Webster, Electrical Impedance Tomography. Adam Hilger, 1990
4. Biomedical Photonics Handbook, T.Yo-Dinh(ed.), CRC Press (2003)
5. Biophotonics, Lorenzo Pavesi, Philippe M. Fauchet (ed.) Springer (2008)
6. Introduction to Biophotonics, Paras N. Prasad Wiley (2003)

BPT-M_22. Computers & Microcontrollers in Medical Devices — 2 Credits

A. Computers (14h)

1. Basic computer system organization: Block diagram showing CPU, memory & input/output devices, Internal and external memory, Volatile and non-volatile memory, large volume data storage. (2h)
2. Internal block diagram of CPU explaining the basic functioning of a computer, concept of program (software), where hardware meets software in a computer. (2h)
3. Buses & registers, program counter, Timing and control section, Instruction register, Program Counter, Memory Address register, Accumulator. (2h)
4. Simple program example, Program execution, Computer operating cycles: Instruction & Execution cycles, Synchronising and controlling of operations. (2h)
5. Programming language types-machine language, Assembly language and high level languages, Interpreter and Compiled program, Executable Files and Source code. (2h)
6. Input/Output: Handshaking: Examples of I/O, Process instruments control, Keyboard entry/Display, Parallel - serial interface , the UART, Asynchronus serial data communication. (2h)
7. Computer Interfacing & Data acquisition. (2h)

B. Microcontrollers (16h)

1. Introduction: Number systems and arithmetic (review), Binary, 2's complement, add, subtract, divide & multiply; Machine model (PIC and Atmel AVR) (2h)
2. Assembly language programming (using PIC): Addressing modes: Access to data, Data sizes, Indirection, Implementation of stacks; Register Set & properties; Instruction Set; Introduction to assembly/linking/simulation process; Modular programming: Use of subroutines - hardware stack, storage allocation; Simple program examples: Searching, sorting and arithmetic operations. (4h)
3. On-chip Peripherals: I/O Ports; Programmable Timer; Interrupts; Serial Peripheral Interfaces; USB Interface; A/D Conversion and sampling, aliasing; Design and interface examples; Writing to EEPROM (4h)
4. C Programming for Embedded Systems (using Atmel AVR): C Compilation & Linking; Program & data organization; Parameter Passing & stack frames; Using C to access hardware; Software building blocks - queues, tables, strings, state machines etc. (4h)
5. Expansion Methods: Memory interfacing and timing diagrams; Memory decoding & buffering. (2h)

BPT-M_23. Biomedical Signal Processing **3 credits**

---

1. The Nature of Biomedical Signals (7h)

   The Reasons for Studying Biomedical Signal Processing, Signals and Systems: Continuous-time and Discrete-time signals, Continuous-time and Discrete-time systems, Analog-to-Digital and Digital-to-Analog Conversions, System function, Causality and Stability, FIR and IIR systems, Some Typical Sources of Biomedical Signals, Deterministic, Stochastic, Fractal and Chaotic signals, Signal Modeling as a Framework for Signal Processing, Noise.

2. Memory and Correlation (2h)

   Memory in a physical system, Energy and Power signals, Concept of autocorrelation.

3. The Impulse Response (2h)

   Convolution as Signal Processing, Relation of Impulse Response to Differential Equation, Convolution as a Filtering Process, Impulse Responses for Nonlinear Systems.

4. Frequency Response (4h)

   Biomedical Example, Generalized Frequency Response, Ideal Filters, Frequency Response and Nonlinear Systems.

5. Modeling Continuous-Time Signals (5h)

   Fourier series representation, The Frequency Response and Nonsinusoidal Periodic Inputs, Parseval’s Relation for Periodic Signals, Continuous-Time Fourier Transform (CTFT): Properties and Examples, Parseval’s Relation for Nonperiodic Signals, Filtering, Output Response via Fourier Transform

6. Responses of Linear Continuous-lime Filters to Arbitrary Inputs (2h)

   Introductory Example, Laplace Transform: Properties and Examples, Biomedical Applications of Laplace Transforms

7. Modeling Discrete-Time Signals (8h)

Discrete-Time Fourier series, Fourier Transform, Relation of DFS and DTFT, The Discrete Fourier Transform (DFT), The Fast Fourier Transform (FFT), Biomedical Applications.

8. Noise Removal and Signal Compensation (12h)

• Introductory example: Reducing the ECG Artifact in an EMG Recording

• The z-Transform: Definition and Properties, Poles and Zeros, Pole locations and Time responses, The inverse z-transform, Analyzing Digital Filters Using z-Transforms, Biomedical Applications of DT Filters, Design of Digital Filters: IIR Filter Design, FIR Filter Design, Adaptive Filtering, Biomedical Applications of Digital Filtering.

9. Modeling Stochastic Signals as Filtered White Noise (3h)

Random Processes, Stationarity and Ergodicity, General Linear Processes, Yule-Walker Equations, Autoregressive (AR) and Moving Average (MA) Processes, Harmonic Processes

Recommended Books:

1. Eugene N. Bruce, Biomedical Signal Processing and Signal Modeling, Wiley Interscience Publication, 2000. (ISBN 0-471-34540-7)
2. Rangayyan, R.M., Biomedical Signal Analysis : A Case-Study Approach, Wiley-IEEE Press, 2001. (ISBN: 0471208116)
3. JG Proakis and DG Manolakis, Digital Signal Processing–Principles, Algorithms and Applications, Prentice-Hall International, Inc.
4. Ifeachor and Jervis, Digital Signal Processing.
5. Hwei P. Hsu, Signals and Systems, Schaum's Outlines. McGraw Hill.
6. Adaptive Filters, Simon Haykin.

BPT-M_29. Practical laboratory work **3 Credits**

A. Circuit design and Testing

1. Optical Heart beat monitor
2. ECG amplifier and measurement
3. EMG amplifier and measurement
4. Nerve Stimulator
5. Galvanic skin resistance measurement
6. Electrode Impedance Measurement
7. Conductometer

B. Physiological measurement

8. Blood Pressure
9. SpO_2
10. Respiration (Spirometry)
11. 12 lead ECG

12. Heart Sound and analysis
13. Electroencephalography (EEG)
14. Nerve Conduction

C. Computer Interfacing & Microcontroller applications

15. Interfacing through printer port
16. Interfacing through USB port using a microcontroller
17. ADC and DAC

BPT-M_30.	**Thesis**	**4 Credits**

D. <u>OTHER MANDATORY ITEMS</u>

(2 credits)

Starts from BPT-M_31

BPT-M_31.	**Viva-voce**	**2 credits**