COURSE OUTLINE

M.Sc Biomedical Engineering

University of Health Sciences
Lahore

OBJECTIVES

University of Health Sciences has designed two year M.Sc Biomedical Engineering programme to have a qualified and skilled manpower with an inter disciplinary problem solving approach in health care. Practical application of this Knowledge is based in Clinical & Research environments, Understanding of the normal functioning & malfunctioning of human body, the functioning of equipment used for diagnosis and treatment in various health care delivery outlets, Ability to undertake corrective and preventive maintenance of the equipment and capability of developing new techniques & equipment.

ENTRY QUALIFICATION

1. B.Sc Electrical Engineering
2. B.Sc Electronic Engineering
3. B.Sc Mechatronics Engineering
4. B.Sc Biomedical Engineering
5. M.Sc Physics with Electronics
6. MBBS

ADMISSION PROCESS

- 20 Students will be admitted annually
- Entry Test for admission
- Admission on open merit basis
- 50% weightage for Entry Test and 50% to Academic Record

INTRODUCTION TO BIOMEDICAL ENGINEERING

Biomedical engineering integrates physical, chemical, mathematical, and computational sciences and engineering principles to study biology, medicine, behavior, and health. It advances fundamental concepts; creates knowledge from the molecular to the organ systems level; and develops innovative biologics, material, processes, implants, devices and informatics approaches for the prevention, diagnosis, and treatment of disease, for patient rehabilitation, and for improving health.

Course Topics & Details

Two years programme is split into ten courses, each of which is separately examined.

First Academic Year

In the first Academic Year the following five courses are included.

1. BME 501 Foundation of Biomedical Engineering
2. BME 502 Biomechanics
3. BME 503 Biomaterials
4. BME 504 Application of Biomedical Engineering
5. BME 505 Practicals ,viva and Log Book

Second Academic Year

In second academic year five courses are included along with research project.

1. BME 506 Biomedical Instrumentation
2. BME 507 Biosignal Analysis
3. BME 508 Safety, protection and quality assurance
4. BME 509 Practicals ,viva and Log Book
5. BME 510 Research Project

Note

Each Course includes

i. 4 Hours for Theory/week
ii. 4 Hours for Practical/week
iii. 6 Months Research Project

FIRST ACADEMIC YEAR

1. Foundation of Biomedical Engineering (BME 501)

1. Cell and organism
2. Organism and population
3. Anatomical positions
4. Surface anatomy
5. Basics of different systems of the body
    i. Cardiovascular system
    ii. The Central nervous system
    iii. The Respiratory system
    iv. The gastrointestinal system
    v. Excretory system
    vi. Reproductive system
    vii. Biochemical system
6. Sources of Biomedical Signals
    i. Bioelectric signals
    ii. Bioacoustics signals
    iii. Biomagnetic signals
    iv. Biooptical signals
    v. Bioimpedence signals

2. Biomechanics (BME 502)

1. Fundamentals of Mechanics
    i. Scalars, vectors, Motion and force Momentum, Waves and Sound, Light, Work, Power, Energy
2. Introduction to Biomechanics
    i. Joints and Muscle Mechanics
3. Forces and movements in the body
    i. Contact Forces
        a. Frictional Force
        b. Tensional Force
        c. Normal Force
        d. Resistance Force
        e. Applied Force

ii. Action-at-a-Distance Forces
    a. Gravitational Force
    b. Electrical Force
    c. Magnetic Force
4. Principle of Kinematics and kinetics
5. Ergonomics Basis
6. Properties of Cartilage, Muscle and Tendon
7. Spinal modeling, Measurement of load and strain in the body

3. Biomaterials (BME 503)

1. Review of material science
    i. Categories of solid materials
    ii. Properties and structure
    iii. Atomic and molecular structure
    iv. Crystalline materials
    v. Non-crystalline materials
    vi. Macrostructure
    vii. Single and multiphase materials
    viii. Solutions
    ix. Mixture
    x. Phase diagram
2. Introduction to Bio Materials
3. Biocompatibility
    i. Immune system response
    ii. Corrosion
    iii. Degradation
    iv. Swelling and leaching
    v. Deterioration of materials
    vi. Effect of degradation product
    vii. Friction and wear
    viii. Lubrication
    ix. Wear
    x. Stress Shielding
4. Mineralized Tissue (Bone and Teeth)
    i. Micro structure of bone

ii. Bone composition (ultra structure) cortical bone
iii. Trabecular bone
iv. Teeth
v. Material properties of hard tissue
vi. Structure properties of hard tissue
vii. Mechanical properties of trabecular tissue
viii. Viscoelastic properties of bone
ix. Fatigue of bone
x. Mechanical properties of whole bone

5. Soft Tissue
   i. Mechanical properties of soft tissues
6. Testing Bones
   i. In vitro mechanical testing of bones
   ii. In vitro density testing
   iii. In vitro structural testing
7. Polymers
   i. Classification
   ii. Polymer molecular weight
   iii. Polymer additives
   iv. Polymer mechanical properties
   v. Polymer thermal behavior
   vi. Polymer for implant
8. Metals for implantation
   i. Steel
   ii. Cobalt –chromium
   iii. Titanium
   iv. Dental metals
   v. Nickel –titanium alloys
9. Soft tissue implants
   i. Artificial skin
   ii. Eye implant
   iii. Ear implant
10. Blood Contacting implants
11. Testing of biomaterials
12. Fracture Fixation
13. Introduction of fracture Mechanics

14. Ergonomics
    i. Wheel chairs
    ii. Seating
    iii. Gait analysis
    iv. Equipment design

4. Application of Biomedical Engineering (BME 504)

1. Imaging Physics
    i. Nuclear Radiations
    ii. Electromagnetic Spectrum
    iii. Basis of Diagnostic Radiology
    iv. Nature and production of X-rays
2. Laser Applications in Biomedical Field
    i. Fundamental of Laser and optics
    ii. Types of laser
    iii. Medical Optics
    iv. Laser and optical Instrumentation techniques in medicine
    v. Laser safety
3. Ultrasound
    i. Physics of ultrasonic waves
    ii. Medical ultrasound
    iii. Biological effect of ultrasound
4. Thermography
    i. Physics of Thermography
5. NMR
    i. Principles of NMR Imaging System
6. Medical Linear Accelerators
    i. Principles of medical linear Accelerators
    ii. External Features and general overview of operation
7. Physics of Radiotherapy & Nuclear Medicine
    i. Radiotherapy
        a. Teletherapy units
        b. Brachytherapy units
        c. Simulators
        d. Treatment planning system

ii. Nuclear Medicine
    e. Radioisotopes:
    f. Isotope dose calibrators
    g. Gamma counters
    h. Basic physics of Gamma Camera
    i. SPECT
    j. Introduction to PET system

8. Radiation Detectors
    i. Physical parameters of X-rays detectors
    ii. Gas filled detectors
    iii. Scintillation detectors
    iv. Semiconductor, detectors
    v. Thermoluminesent detectors
9. Basic Principle of Radiation Protection
10. Units and Biological effects of Ionizing radiations
    i. Stochastic & Deterministic effects of Ionizing Radiations
    ii. MPD (Maximum Permissible Doses)
    iii. Low level Electromagnetic fields

5. Practicals, Viva & Log Book (BME 505)

1. Basic trouble shooting equipments
    i. Digital Multimeters
    ii. Dosimeters
    iii. Oscilloscope
    iv. Gas detectors
    v. Lux meter
    vi. Clamp meter
    vii. Spectrum analyzer
    viii. Trainers
    ix. Pattern generator
2. Cobalt 60 teletherapy systems
3. Gamma Camera
4. Diagnostic X-ray machine
5. Linear Accelerator
6. Ultrasound

SECOND ACADEMIC YEAR

1. Biomedical Instrumentation (BME 506)

(Measuring, Recording & Monitoring Instruments)

1. Fundamental of medical instrumentation

i. Basic Medical Instrumentation system

ii. Intelligent Medical Instrumentation system

2. Bioelectric signals and electrode

i. Origin of Bioelectric signals

ii. Recording Electrodes

iii. Electrodes for ECG

iv. Electrodes for EMG

v. Electrical Conductivity of Electrodes Jellies and Creams

vi. Microelectrodes

3. Physiological transducers

i. Introduction

ii. Classification of transducer

iii. Performance Characteristics

iv. Displacement, Position and Motion transducers

v. Pressure transducers

4. Recording systems

i. Basic recording signals

ii. General Consideration for signals Conditions

iii. Preamplifiers

iv. Sources of Noise in Low Measurements

v. Biomedical Signal analysis techniques

vi. Signal processing Techniques

vii. The main Amplifier and Driver Stage

viii. Writing Systems

ix. Direct Writing recorders

x. The Ink jet recorder

xi. Digital recorders

xii. Instrumentation tape recorders

5. Patient monitoring system

i. System concept
ii. Cardiac monitor
iii. Bedside Patient Monitoring system
iv. Central Monitors
v. Measurement of Heart rate
vi. Measurement of Pulse rate
vii. Blood pressure Measurement
viii. Measurement of temperature
ix. Measurement of Respiratory rate
x. Catheterization Laboratory Instrumentation

6. Arrhythmia and Ambulatory monitoring instruments

i. Cardiac Arrhythmias
ii. Arrhythmias monitors

7. Fetal monitoring instruments

i. Cardiotocograph
ii. Methods of monitoring Fetal Heart Rate
iii. Monitoring labour activity
iv. Recording systems

8. Clinical laboratory instruments

i. Medical diagnostic with chemical tests
ii. Spectrophotometery
iii. Spectrophotometer type instruments
iv. Colorimeters
v. Spectrophotometer
vi. Automated Biochemical analysis Systems
vii. Clinical flame Photometer
viii. Selective –ion Electrodes Based Electrolytes

9. Blood gas analyzer

10. Blood cell counter

11. Audiometers and hearing aids

i. Mechanism of Hearing
ii. Measurement of sound
iii. Basic Audiometer

12. X- Ray machine and digital radiography

i. X-Ray machine

ii. Dental X-Ray machine Physical parameters of X-Ray detectors

iii. X-Ray detectors

iv. Digital Radiography

13. Mammography:

i. Construction and function of digital mammography

14. Computed Tomography:

i. System components

ii. Image reconstruction

iii. Gantry geometry

iv. Patient dose in CT scanner

15. Nuclear medicine imaging system

i. Radiopharmacy

ii. Radiation Detectors

iii. Pulse Height Analyzer

iv. Thyroid uptake system

v. Gamma camera

vi. Single photon Emission Computed Tomography (SPECT)

vii. Positron Emission Tomography (PET)

viii. Cyclotron

16. Magnetic resonance imaging system:

i. Principle of NMR Imaging system

ii. Image Reconstruction Techniques

iii. System components

iv. Advantage of NMR Imaging system

17. Ultrasonic imaging system:

i. Physics of ultrasonic waves

ii. Medical ultrasound

iii. Basic pulse-echo apparatus

iv. A scanner

v. B scanner

vi. Real time ultrasonic Image system

vii. Multi-element linear array scanners

viii. Multi Element phased array scanner

ix. Signal processing

x. Doppler Techniques

xi. Color coded Doppler Images

18. Thermal Imaging System:

i. Medical thermography

ii. Infrared Detectors

iii. Thermographic equipment

iv. Quantitative medical Thermography

(Therapeutic Equipments)

19. Cardiac pacemakers:

i. Need for Cardiac Pacemaker

ii. External Pacemaker

iii. Implantable Pacemaker

iv. Pacing system Analyzer

v. Recent developments in Implant pacemakers

20. Instruments for surgery

21. Laser application in biomedical equipment

i. The laser

ii. Pulsed Ruby Laser

iii. ND-YAG Laser

iv. Helium – Neon Laser

v. Argon Laser

vi. CO2 Laser

vii. Excimer Laser

viii. Semiconductor Lasers

ix. Laser safety

22. Haemodialysis Machines

i. Function of Kidney

ii. Artificial Kidney

iii. Dialyzers

iv. Membranes for Haemodialysis

v. Haemodialysis

vi. Portable kidney Machines

23. Lithotripters

i. First lithotripter systems

ii. Modern Lithotripter systems

24. Anesthesia Machine

i. Anesthesia Machine

ii. Electronics in Anesthesia Machine

25. Ventilators

i. Artificial ventilation

ii. Types of ventilators

iii. Classification of ventilators

iv. Modern ventilators

v. Humidifiers

vi. Nebulizers

vii. Aspirators

26. Physiotherapy equipment

i. High frequency heat therapy

ii. Short wave diathermy

iii. Electrical stimulators

iv. Ultrasonic therapy unit

27. Radiotherapy Equipment

i. Co- 60 Machine

ii. Medical Linear Accelerators

iii. Brachytherapy machine

iv. Simulators

v. Computerized treatment planning systems

vi. Dosimetery systems

2. Biomedical signals and systems (BME 507)

1. Introduction to Biomedical Signals and Systems
2. Signals from Physiological Systems
3. Signals from man made Instruments
4. Discrete signals
5. Modulation and demodulations of physiological signals
6. Properties of physiological systems
7. Linear system theory
8. Linear system characterization

9. Discrete signals and system
10. Introduction to laplace transforms and its application
11. Fourier series Analysis of periodic signals
12. The continuous Fourier transform
13. Introduction to time frequency Analysis of Biomedical signals
14. Digital filters
15. Introduction to computers In Medicine (Intelligent systems in medicine)

3. Safety, Protection & Quality Assurance (BME 508)

1. Biostatistics
2. Medical ethics
3. General safety
4. Equipment management safety
5. Radiation protection
6. Electrical safety
7. Chemical safety
8. Non ionizing radiations
9. Biological hazards
10. Quality management
11. Software safety
12. Mechanical workshop safety

4. **Practical Demonstration & Training (BME 509)**

1. Recording systems
2. Patient monitoring systems
3. Arrhythmia and Ambulatory monitoring instruments
4. Fetal monitoring instruments
5. Clinical Laboratory instruments
6. Blood gas analyzer
7. Blood cell counter
8. Audiometers and hearing aids
9. Computed Tomography
10. Magnetic resonance imaging systems
11. Cardiac pacemakers

12. Laser applications in biomedical equipment
13. Haemodialysis Machines
14. Lithotripters
15. Anesthesia Machine
16. Ventilators
17. Physiotherapy equipment
18. Radiotherapy equipment

5. Project (BME 510)

1. Research project shall be prepared by the candidate in consultation with the supervisor.