COLLEGE REQUIREMENTS (24 CR.)

Course No.	Course Title	No. of Hours			Prerequisites
		Theory	Practice	Credit	
CS101	Programming with Selected Language	3	-	3	CS100
Math101	Calculus I	3	-	3	-
Math102	Calculus II	3	-	3	Math 101
Math 203	Ordinary Differential Equations (1)	3	-	3	Math 102
Phy 101	General Physics I	3	-	3	-
Phy 105	General Physics Lab. I	-	3	1	Phy 101*
Phy 102	General Physics II	3	-	3	Phy 101
Phy 106	General Physics Lab. II	-	3	1	Phy 102*
Chem 101	General Chemistry.	3	-	3	-
Chem 105	General Chemistry Lab.	-	3	1	Chem 101*

***Co-requisite course, i.e., can be taken together**

DEPARTMENT REQUIREMENTS (116 CR.)

4. Biomedical Systems Engineering Compulsory Requirements (104 Cr.)

Course No.	Course Title	No. of Hours			Prerequisites
		Theory	Practical	Credit	
Bio 108	Human Biology	3	-	3	-
BME 102	PathoPhisology I	3	-	3	Bio 108
BME 105	PathoPhisology Lab.	-	3	1	BME102*
BME 200	Introduction to Medical Informatics	3	-	3	CS101
EPE 200	Engineering mechanics	3	-	3	PHY 101
BME 202	Introduction to Cybernetics	3	-	3	Math 203
STAT 203	Biostatistics	3	-	3	Bio. 102 or Geo 102 or Bio 108
BME 204	Introduction to Biomedical Systems Engineering	3	0	3	BME 202
BME 205	Software tools for Biomedical Systems Lab.	0	3	1	BME 204*
EPE 220	Electrical Circuits I	3	-	3	PHY 102
EPE 222	Electrical Circuits II	3	-	3	EPE 220
EPE 223	Electrical Circuits Lab.	-	3	1	EPE 220
CPE 250	Object Oriented Programming	3	3	4	CS101
CPE 250 L	Object Oriented Programming lab.	0	3	0	-------
ELE 250	Electronics I	3	-	3	EPE 220
ELE 251	Electronics I Lab.	-	3	1	ELE 250*
BME 300	Biomechanics I	3	0	3	EPE 200
CME 312B	Signals & Systems	3	0	3	EPE 220
ELE 353	Electronic Design & Manufacturing Lab.	0	3	1	BME 356
BME 356	Medical Electronics	3	-	3	ELE 250
BME 357	Medical Electronics Lab.	-	3	1	BME 356*

MIS 361	Software Project Management	3	-	3	-
BME 366	Programmable Circuits & Microcontrollers	3	0	3	BME 356
BME 367	Programmable Circuits & Microcontrollers Lab.	0	3	1	BME 366*
BME 380	Medical Transducers	3	0	3	BME 356
BME 390	Biomedical Signal Processing	3	0	3	CME 312B
BME 391	Biomedical Signal Processing Lab.	0	3	1	BME 390*
BME 396	BioFluids	3	0	3	EPE 200
BME 400	Ethics in Biomedical Engineering	1	0	1	BME 204
BME 420	Medical Instrumentation	3	0	3	BME 380
BME 421	Medical Instrumentation lab	1	3	1	BME 420*
BME 422	Concepts of Medical Imaging	3	0	3	BME 380
CpE 450B	Information Systems & Database	3	3	4	CpE 250
CpE 450L	Information Systems & Database Lab.	0	3	0	CpE 250
ELE 455	Specialized Measurements lab.	0	3	1	BME 380*
BME 460	Medical Instruments	3	0	3	BME 420
BME 461	Medical Instruments Lab.	0	3	1	BME 460*
BME 462	Medical Imaging Modalities	3	0	3	BME 422
BME 464	Advanced Biomedical Signal Processing	3	0	3	BME 390
BME 465	Advanced Biomedical Signal Processing Lab.	0	3	1	BME 464*
BME 498A	Primary Graduation Project	0	3	1	Department Decision
BME 500A	Field Training in BioMedical Systems	Six Months	9		Department Decision
ELE 551	Maintenance Lab.	0	3	1	BME 356 or ELE 351A
BME 598A	Secondary Graduation Project	0	6	3	BME 498A

***Co requisite course, i.e., can be taken together**

5. Biomedical Systems Engineering Optional Requirements (12 cr.)

Course No.	Course Title	No. of Hours			Prerequisites
		Theory	Practical	Credit	
BME 104	PathoPhisology II	3	-	3	BME 102
EPE 340	Thermodynamics & Heat Transfer	3	0	3	PHY 102
BME 430	BioInformatics I	3	0	3	BME 102
BME 440	e-Health	3	0	3	BME 420
BME 544	Medical Image Processing.	3	0	3	BME 390
BME 560	Computer Assisted Diagnosis & therapy	3	0	3	BME 460
BME 562	Bioelectricity & Biomagnetism	3	0	3	BME 420
BME 564	Telemedicine	3	0	3	BME 460
BME 566	Radiology & Dosimetry	3	0	3	BME 462
BME 568	BioMEMS	3	0	3	BME 460
BME 570	Bioengineering Design Concepts	3	0	3	BME 300
BME 572	Medical Systems & Environment Safety	3	0	3	BME 460
BME 574	Biomechanics II	3	0	3	BME 300
BME 576	Biomaterials	3	0	3	BME 300
BME 596A	Special Topics	3	0	3	Department Decision

***Co requisite course, i.e., can be taken together**

COURSE DESCRIPTION (COLLEGE REQUIREMENTS**)**

1. CS101: Programming In A Selected Language (3 Cr. Hrs.)

It covers the basic concepts, properties, data representation, and syntax of a selected programming language. Students will learn how to use the structured programming approach. The course also covers the foundations of object-oriented programming.

2. Math. 101 - Calculus (1) (3 Cr. Hrs.)

Limits, continuity, and derivative: Tangent and normal lines, local extrema, concavity. Related rates. Vertical and horizontal asymptotes. The mean value theorem of differentiation and its applications. The definite integral, the fundamental theorem of calculus, the indefinite integral. Applications of the definite integral: Area, solids of revolutions, volumes using cylindrical shells, arc length. The transcendental functions: The general exponential and Logarithmic functions. The hyperbolic functions, the inverse function of the trigonometric and hyperbolic function.

3. Math. 102 - Calculus (2) (3 Cr. Hrs.)

Techniques of integration: Integration by parts, trigonometric substitutions, partial fractions, quadratic expressions. The conic sections. Plane curves and polar coordinates: Parametric equations, tangent lines, area in polar coordinates, surface of revolution. Indeterminate forms and improper integrals. Sequences and infinite series: convergence and divergence, positive term series, alternating series, absolute and conditional convergence. Power series: Differentiation and integration, Taylor series.

4. MATH. 203 - Ordinary Differential Equations (1) (3 Cr. Hrs.)

Introduction and classification, solutions of first order differential equations and their applications, (Growth and decay problems and linear motion problems). Solutions of higher order linear differential equations and their applications (Spring problem and projectile problems). Series solutions of differential equations near ordinary points. Solution of ordinary differential equations by Laplace transforms.

5. PHYS 101 - General Physics (1) (Mechanics) (3 Cr. Hrs.)

Measurement and system of units, Vectors, Motion in one and two dimensions, Particle dynamics and Newton's laws of motion, Work and energy, Conservation of energy, Dynamics of system of particles, Center of mass, Conservation of linear momentum, Collisions, Impulse, Rotational Kinematics, Rotational Dynamics, Conservation of angular momentum, Elasticity, Gravity, Fluids.

6. PHYS 102 - General Physics (2) (Electricity and Magnetism) (3 Cr. Hrs.)

Charge and matter, Electric field, Gauss's law, Electric potential, capacitors and dielectrics, current and resistance, electromotive force and circuits, the magnetic field,

Ampere's law, Faraday's law of induction, Maxwell's equations; magnetic properties of matter, A.C circuits.

7. PHYS 105 - General Physics Laboratory (1) (Mechanics) (1 Cr. Hr.)

12 experiments covering the topics discussed in physics 101.

8. PYHS 106 General Physics, Lab. (2) (Electricity and Magnetism) (1 Cr. Hr.)

12 experiments covering the topics discussed in physics 102.

9. Chemistry 101 : General Chemistry I. (3 Cr. Hrs.)

Scientific Measurements, Stoichiometry, Chemical reactions, Atomic Structure, Molecular Structure, Periodic Table, Chemical Bonding, Gases and their Laws, States of Matter and Forces among Molecules.

10. General Chemistry Lab. (I) (1 Cr. Hrs.)

Lab. Safety and Basic Lab. Techniques, Formula of Hydrate, Empirical Formula of a Compound, Limiting Reactant, Periodic Chart and Periodic Law, Spectroscopy and Molecular Geometry, Properties of Inorganic Compounds and Metathesis Reactions, Molecular Weight of a Volatile Liquid, Preparation of an Alum, Aspirin Synthesis, Standardization of NaOH solution; Equivalent Weight of an Acid, Colligative Properties (FW Determination).

DEPARTMENT REQUIREMENTS:

1. **Bio 108 Human Biology (3 cr. Hrs)**

Survey of human body structure and function. Starting at biological macro-molecules, levels of organization, cells, tissues and ending at the level of human body systems (skeletal, muscular, nervous, cardiovascular, respiratory and digestive systems). Topics include human inheritance (from chromosomes to biotechnology), human reproduction (male and female anatomy and physiology), fetal development and birth. On modular basis, students will be introduced to techniques and machinery applied in medicine for diagnostic procedures. ECG, EMG, EEG, Blood testers, ..etc.

2. BME 102 PathoPhysiology I, Prerequisite: Bio 108 (3 cr. Hrs)

Covers the physiology and basic mechanisms of diseases and selected common disorders of the following systems: cardiovascular, cardiac diseases, Hypertension, Coagulation disorders, Atherosclerosis, Aneurysms and Dissections of blood vessels, Heart Failure, Ischemic Heart diseases, Valvular Heart diseases; respiratory, Bronchial asthma, Chronic obstructive pulmonary disease**,** Bronchitis and bronchiactasis, Respiratory failure; hematopoeitic, Red blood cell disorders, White blood cell disorders, Platelet disorders; renal system, reneal diseases, renal failure.

3. BME 104 pathophysiology II, Prerequisite: BME102, (3 Cr. Hrs.)

It includes the physiology and basic mechanisms of diseases and selected common disorders of the following systems: gastrointestinal and hepatobiliary, genital, endocrine, musculoskeletal, and nervous systems.

4. BME 105 PathoPhisology Lab. Prerequisite: BME 102 (1 cr. Hr)

The lab will cover the fundamental concepts of human physiology and its pathology. It includes experiments that covers the following topics: Cells and tissues, Diffusion, osmosis, and tonicity, Enzymes, Nervous System, Special Senses, Endocrine glands, Skeletal muscle, Blood, The Heart, Blood Flow, Blood Pressure, and ECGs, Respiration, Digestion, and Renal (Urinary) System. Furthermore, clinical workflows and the related information processes will be studied.

5. BME 200 Introduction to Medical Informatics Prerequisite : CS 101 (3 cr. Hrs)

Introduction to health care Information systems and its applications. Locating, manipulating, and displaying information in health care settings. Medical records and hospital and patient information handling. Both conventional and proposed patient and hospital information systems will be discussed as well as the impact of governmental, state and local regulations on the security and transfer of medical information. Experiences with information and workflow in a hospital as well as with organizational aspects are necessary for teaching this course.

6. EPE 200 Engineering Mechanics, Prerequisite: PHY 101 (3 Cr. Hrs)

Force analysis, equilibrium of particles, moment of forces, vector products, moment of couple. Reactions and supports. Equilibrium of rigid bodies. Truss analysis. Kinematics of rigid bodies. Plane motion of rigid bodies (force, acceleration, energy and momentum).

7. BME 202 Introduction to Cybernetics Prerequisite: Math 203 (3 Cr. Hrs)

Cybernetic systems in biology, basic components and structures of control systems, automatic control, systems analysis, control theory, dynamics of feedback systems quantitative description of linear systems, examples of biological control systems, examples for reception, transmission, and processing of information by receptors and neurons, and neural networks.

8. STAT 203 Biostatistics (Geology and Biology Students), Prerequisite: Bio. 102 or Geo 102 or Bio 108 (3 Cr. Hrs)

Collecting samples. Tables and graphical representation of the geological and biological data. Probability and its properties. Point and interval estimation, testing hypothesis. Categorical data. Linear regression and correlations. Biostatistics. Analysis of real data.

9. BME 204 Introduction to Biomedical Systems Engineering, Prerequisite: BME 202 (3 Cr. Hrs)

Introduces the interdisciplinary nature of the Biomedical Engineering Technology program through engineering and medical terminology. Presents hospital and industrial policies, procedures and codes with an emphasis on safety. Introduces biomedical instrumentation, control systems and the man-machine interface. Introduces techniques for analysis and modeling of biomedical systems. Application of mathematics (including Differential Equations, Laplace Transforms and Statistics) and computer-aided methods to study problems at the interface of engineering and biology. Elements of physiological modeling and the solution of the transient and forced response for a variety of biomechanical, biomaterial, bioelectrical and biochemical systems.

10.BME 205 Software tools for Biomedical Systems Lab, co-requisite BME 204, (1 Cr. Hr.)

Introduces state of the art software packages that will be applied to simulate and model problems at the interface of engineering and biology. Apply mathematical techniques on biomedical informatics engineering problems including numerical methods, equation solutions, curve fitting and approximation etc.

11. EPE 220 Electrical Circuits I, Prerequisite: PHY 102 (3 Cr. Hrs)

System of units, circuit variables (charge, current, voltage, power, energy). Circuit elements, and simple resistive circuits. Techniques of circuit analysis. The ideal operational amplifier, inductance and capacitance. Natural and step responses of first order RL and RC circuits. Natural and step responses of RLC circuits.

12. EPE 222 Electrical Circuits II, Prerequisite: EPE 220 (3 Cr. Hrs)

Sinusoidal steady state analysis. AC power analysis (instantaneous, average power, maximum power transfer, complex and apparent power, power factor and power factor correction. Analysis of three-phase circuits. Mutual inductance and magnetically coupled circuits. Resonance circuits. Frequency response using Bode plots. Two-Port networks.

13. EPE 223 Electrical Circuits II, Co-requisite: EPE 220 (1 Cr. Hrs)

Measuring devices (Ammeter, Voltmeter, Oscilloscope), DC circuit analysis (Ohm`s law, KCL, KVL, current division, voltage division, series/parallel combinations of resistors, wheatstone bridge, Thevenin`s and Norton`s equivalent circuits, maximum power transfer), RLC components and their frequency dependence, frequency resonance of RL and RC Circuits, phase measurements using the oscilloscope, series sinusoidal circuits, parallel sinusoidal circuits, series-parallel sinusoidal circuits, Thevenin`s theorem and maximum power transfer, resonant circuits, frequency response of filters (low-pass, high-pass, Band-pass).

14. CPE 250 Object Oriented Programming, Pre-requisite: CS 101, (3 Cr. Hrs.)

Overview of C++, C#, and java, Object Oriented Programming methodologies, Classes and data abstraction, Constructors and destructors, Operator Overloading and conversions, Subclasses and Inheritance, Virtual functions and polymorphism, Templates and Exception handling.

15. CPE 250 L Object Oriented Programming Lab., Co-requisite: CPE 250, (1 Cr. Hr.)

This lab will provide hands on experience on theoretical topics of object oriented programming in a comprehensive application.

16. ELE 250 Electronics I, Prerequisite: EPE 220 (3 CR. Hrs.)

P-N junction diodes, diode applications (rectification, regulation, clipper, voltage multipliers), bipolar junction transistor (construction, operation, biasing and stability, DC and AC modeling of BJT, design of CB, CE and CC amplifiers), field effect transistor (construction, operation, JFET, MOSFETS, AC modeling of JFET, design of FET amplifiers, CS, CD, CG amplifiers), transistors as switches.

17. ELE 251 Electronics I Lab., co-requisite ELE 250, (1 Cr. Hr.)

Diode characteristics, Zener diode, small and large signal diode circuits, rectification and regulation circuits, clippers, clampers, voltage multipliers, BJT characteristics (CB, CE and CC), BJT and JFET AC- parameters, biasing of BJT and JFET circuits, BJT- amplifiers, JFET- amplifiers.

18. BME300 Biomechanics I, Prerequisite: EPE 200, (3 Cr. Hrs.)

Fundamental mechanical principles will be reviewed, with subsequent application to the major joints and structures of various regions of the human body, and the integration of biomechanics with other exercise and sport science disciplines. An introduction to the structure and mechanics of the musculoskeletal system and to the properties and strength of biological materials, application of Newtonian mechanics, statics, and strength of materials to bone, muscle, tendon, and other biological material.

19. CME 312 Signals and Linear Systems, Prerequisite: EPE220. (3 Cr. Hrs.)

Continuous and discrete time signals and systems, continuous and discrete time convolution, continuous and discrete LTI systems, Fourier analysis for continuous-time signals, properties and applications of Fourier transform, Laplace transform and z-transform. Filter design techniques.

20. EPE 340 Thermodynamics & Heat Transfer, Prerequisite: PHY101, (3 Cr. Hrs.)

Introduction, some concepts and definitions, properties of a pure substance, work, heat transfer modes, conduction, convection and radiation. The first law of thermodynamics, control mass, control volume, entropy, some power and refrigeration systems, steam and gas power plants.

21. ELE 353 Electronic Design & Manufacturing Lab., Prerequisite: ELE 351 A or BME 356, (3 CR. Hrs.)

Bread boarding and testing, printed wiring board (PWB) design phase (manual and automatic (CAD drawing and photo plotting imaging system)), layout drawing methods and considerations, artwork drawing, drill plan drawing, master film, PWB fabrication phase (manual and automatic (CAM), UV exposuring, photo resist, etching, drilling, assembly, soldering), testing and packaging.

22. BME 356 Medical Electronics, Prerequisite: ELE 250, (3 Cr. Hrs.)

Multistage amplifiers, Frequency response, Power Amplifiers, Operational Amplifiers, special amplifiers (differential amplifier, Instrumentation amplifier, etc), functional integrated circuits (V/f converters, A/D converters, etc), Active Filters.

23. BME 357 Medical electronics Lab, Co-requisite: BME 356, (1 Cr. Hr.)

Multistage amplifiers, Power Amplifiers, Differential Amplifiers, Instrumentation Amplifier, Special circuits (V/f converters, f/V converter, Log-Amplifiers, etc), Active Filters: low-pass, high-pass, band-pass and band-stop filters.

24. MIS 361 Software Project Management, (3 Cr. Hrs.)

An introduction to the fundamental concepts of team based project management and use of information technology resources to develop information systems. Presents the

technical, managerial, and organizational concepts and tactics associated with managing software development and/or acquisition projects.

25. BME 366 Programmable Circuits & Microcontrollers, Prerequisite: BME 356, (3 Cr. Hrs.)

Analysis and design of digital circuits (combinational and sequential), A/D and D/A converter, digital design with hardware-programmable, digital design using VHDL, microprocessors, microcontrollers and picocontrollers, DSP devices.

26. BME 367 Programmable Circuits & Microcontrollers Lab., Co-requisite: BME 366, (1 Cr. Hrs.)

Experiments that handle different applications of digital electronic circuits and microcontrollers.

27. BME 380 Medical Transducers, Prerequisite: BME 356, (3 Cr. Hrs.)

Theory and principles of biosensor design and application in medicine and biology. Analysis and selection of physical, optical, electrical, mechanical, thermal transduction mechanisms, which form the basis of the biosensor design. Principles and fundamental properties of transducers (dynamics, linearity, hysteresis, and frequency range). Blood flow and volume measurement, temperature measurement, muscle contraction transducers, biopotential measurements, radioactive sensors, optical fiber sensors, electrochemical and optical sensors, oxygen sensors.

28. BME 390 Biomedical Signal Processing, Prerequisite: CME 312, (3 Cr. Hrs.)

Acquisition and sampling of biosignals; Shannon's Theorem; continuous and discrete time signals, z-transform, FIR and IIR filters, Fourier series and Fourier transform, power spectrum estimation, filter techniques for modeling biomedical signals, noise removal and signal compensation. Introduction to computer aided ECG processing, EEG-processing in the time and frequency domain; signal averaging of EP's.

29. BME 391 Biomedical Signal Processing Lab., Co-requisite: BME 390 (1 Cr. Hr.)

Origin, description and characteristics of biomedical signals. Reduction of interferences. Digital Filters (FIR filters, IIR filters, integer filters). Temporal analysis. Spectral analysis. Compression of biomedical signals. Introduction to time-frequency analysis.

30. BME 396 BioFluids, Prerequisite: EPE 200, (3 CR. Hrs.)

This course covers the Geometry and Electrical system of the heart. Circulatory Biofluid mechanics, Blood rheology, Newtonian and non-Newtonian fluid mechanics. Pulsatile flow, vortex control of valve motion, and regurgitation. The thixotropic

nature of blood. Shear-rate and time-dependent viscosity of blood. Other biological fluids such as mucous and spinal fluid will also be covered. Overview of airway flow in the lung and the effects of aerosols.

31. BME 400 Ethics in Biomedical Engineering, Prerequisite: BME 204, (1 CR. Hr.)

This course introduces the wide spectrum of ethical, regulatory, and legal issues facing health care practitioners and biomedical engineers. Lectures and discussions help students become aware of the ethical and legal issues involved in their work. The course introduces students to the processes involved in making ethical and legal decisions in matters related to human health and biomedical research. Students are also provided with several sources of additional help and guidance for further investigation and analysis.

32. BME 420 Medical Instrumentation, Prerequisite: BME 380, (3 Cr. Hrs.)

Noise sources and noise reduction techniques, Bioamplifiers and signal conditioning grounding and shielding techniques, electrical safety and basic concepts of biosensor, biomedical instrumentation, basic theories of measurements, cardiovascular measurements. Patient care and monitoring, measurements in the respiratory system, noninvasive diagnostic instrumentation.

33. BME 421 Medical Instrumentation lab., Co-requisite: BME 420, (1 Cr. Hrs.)

Principles of Electrodes, transducers, noise, precision, aliasing, Nyquist theorem, sampling, the hardware and instrumentation needed to measure variables from different physiological systems. Bioelectric amplifiers and biomedical signal conditioning. Hardware for measurement of the ECG, EEG, EMG, respiratory system, nervous system. Clinical laboratory instruments and Electrical safety.

34. BME 422 Concepts of Medical Imaging, Prerequisite: BME 380, (3 Cr. Hrs.)

Diagnostic Ultrasound Imaging, Magnetic Resonance Imaging (MRI), Radiographic Imaging Systems, Emission Imaging systems, Comparison of Imaging modes.

35. BME 430 BioInformatics I, Prerequisite: BME 102, (3 Cr. Hrs.)

Introduction to *Bioinformatics*, principles and computational methods for organizing and maintaining large volume of genomic data. Genome sequencing projects, proteomics and gene expression studies. Fundamentals theories will be presented to define the modeling philosophy and principles as well as simulation methodologies for the integration of genomic and physiological data in the analysis of complex biological processes and for diagnostic matters.

36. BME 440 e-Health, Prerequisite: BME 420, (3 Cr. Hrs.)

Internet based healthcare delivery systems, conventional and novel telemedicine systems, remote consultation systems and their use in clinical decision making process; tele-surgery, tele-pathology concepts, use of e-health by public health agencies; e-commerce in healthcare, planning, developing, and maintaining Web sites and supporting information systems. Business processes, online payments and international legal, privacy and security issues.

37. CpE450B Information Systems & Database, Prerequisite: CpE 250, (4 Cr. Hrs.)

Introduction and History, DBMS Architecture, Storage Hierarchy, Indexes, Entityrelationship (E-R) modeling, The relational model, Relational Query Language (SQL), Query processing and optimization, Transaction Processing (Transactional properties, Concurrency control, Locking, and Crash recovery), introduction to distributed databases. Required software tools: A main-stream commercial DBMS such as SQL 2000 or Oracle. Individual projects are given for the students to sharpen their database development skills using latest software tools and concepts.

38. CpE450B Information Systems & Database, Co-requisite: CpE 450B, (0 Cr. Hr.)

Hands on experience related to the main topics covered by CpE450B.

39. ELE 455 - Specialized Measurements Lab., Prerequisite: ELE 404 or BME 380, (1 Cr. Hr.)

Displacement and angular measurements, liquid flow measurements, PH, humidity, and conductivity measurements, pressure measurements, thermal sensors and its measurements, velocity measurements, optical transducers, spectrum analyzer (analysis and system identification), project.

40. BME 460 Medical Instruments, prerequisite: BME 420, (3 CR. Hrs.)

General principles of signal acquisition, amplification processing, recording, and display in medical instruments. System design, construction, and evaluation techniques will be emphasized. Monitoring systems for bioelectric signals. Cardiovascular system measurements. Respiration monitoring and apnea detection. Electrical stimulation devices: pacemaker, internal and external defibrillators, neuromuscular stimulators. Therapeutical and surgical equipment. Clinical laboratory instruments. Each student will design, construct, and demonstrate a functional medical instrument and collect and analyze data with that instrument. Formal write-ups and presentations of each project will be required.

41. BME 461 Medical Instruments Lab., Co-requisite: BME 460, (3 CR. Hrs.)

It provides hands-on laboratory experience with common biomedical transducers and instrumentation used in physiological and clinical evaluation. Laboratory experiments cover electronic circuit design and construction, analog- digital signal acquisition and processing and computer-based biomedical instrumentation. In addition to assigned laboratory experiments, each student will be required to develop a prototype stand-alone or computerized biomedical instrument to demonstrate the design and implementation.

42. BME 462 Medical Imaging Modalities, Prerequisite: BME 422, (3 CR. Hrs.)

Imaging Theory, Projection Radiography, Tomography (Projection-slice theorem, Convolution-back projection, etc),Magnetic Resonance Imaging (Spin physics, Bloch equation, Signal equation, K-space trajectories, Projection reconstruction, 2D Fourier transform trajectory, Image contrast, MRI SNR, Excitation K-space),Ultrasound (Ultrasound echo equation, Geometric extension of transducer, Impulse response, Diffraction (Fresnel and Fraunhofer regions), Lateral and depth resolution, Phased array systems)

43. BME464 Advanced Biomedical Signal Processing, Prerequisite: BME390, (3 Cr. Hrs.)

Parametric modeling, modern spectral estimation, multivariate analysis, adaptive signal processing, decimation/interpolation, wavelets, and two-dimensional signal analysis. Principal component analysis, Independent component analysis (ICA), Nonlinear methods. There will be several computer projects, which apply these modern techniques to physiologic data.

44. BME465 Advanced Biomedical Signal Processing Lab, Co-requisite: BME464, (1 Cr. Hr.)

Experiments on parametric modeling, modern spectral estimation, multivariate analysis, adaptive signal processing, decimation/interpolation, wavelets, two-dimensional signal analysis, PCA, ICA, and nonlinear methods for several physiological data.

45. BME 498A Graduation Pre-Project Prerequisite: Directed by the Department, (1 Cr. Hr.)

Theoretical investigation and problem identification of a special project in Biomedical engineering under the supervision of an academic faculty member, detailed report as well as an oral examination are required.

46. BME 500A Field Training, Prerequisite: directed by the department, (9 Cr. Hrs.)

A training period of six month to be spent in the Biomedical engineering industry, hospitals, companies or research centers (inside or outside Jordan), under the follow up of an academic faculty member from the department, periodic reports and a final report must be submitted for evaluation, an oral examination is required.

47. BME 544 Medical Image Processing, Prerequisite: BME 390, (3 Cr. Hrs.)

Fundamental concepts of low and high level image processing algorithms used in medical image analysis (such as those that occur in MRI,CT,PET or SPECT imaging). A basic review of image acquisition, through low level processing to high level object extraction and recognition: Image enhancement, restoration, filtering, segmentation, morphology, texture, presentation & description, compression, recognition & interpretation, and registration. These topics will be demonstrated throughout projects.

48. ELE 551 Maintenance Lab., Prerequiste: ElE 351A or BME 420, (1 Cr. Hr.)

Fault diagnosis for a set of experiments in selected electronic systems, mainly in radio, TV receivers and VCRs.

49. BME 560 Computer Assisted Diagnosis & therapy, Prerequisite: BME 460, (3 Cr. Hrs.)

Applications for computers in diagnosis, monitoring and therapy. Applications on this technology will be emphasized such as Computer aided detection in mammogram, ECG recording and diagnosis, microscopic tissue classification, skin cancer classification, radiation therapy planning, sleep staging, computer aided surgery and robotics in surgery.

50. BME 562 Bioelectricity and Biomagnetism,Prerequisite:BME 420, (3 Cr. Hrs.)

Vector Analysis, Electrical Sources and Fields, Introduction to Membrane Biophysics, Action Potentials, Volume Conductor Fields, Electrophysiology of the Heart,

Electrocardiography (ECG), electric and magnetic lead fields, Electroencephalography (EEG), Magnetoencephalography (MEG). This course deals with the inherent electrical properties of cardiac and brain tissues. It presents a comprehensive quantitative treatment of ion channels, transmembrane and intracellular ion fluxes and other bioelectricity-biomagnetism related events on the molecular and cellular level. Clinical importance of the discussed phenomena is emphasized and the acquired knowledge is put into perspective.

51. BME 564 Telemedicine, Prerequisite: BME 460, (3 Cr. Hrs.)

Overview of telemedicine in the context of the general health care system, application of telemedicine in various medical specialties and settings, e.g., countryside, military/aerospace and corrections; variety of issues in implementing operating a telemedicine program including business plan development, technology, economics, legal/ethical, training, protocol development, and evaluation.

52. BME 566 Radiology & Dosimetry, Prerequisite: BME 462, (3 Cr. Hrs.)

This course covers the fundamental approaches to radiation protection in radiology, nuclear medicine, radiotherapy, and research environments at medical facilities. Topics presented include health effects, radiation dosimetry and dose estimation, Radiation planning systems, functional methods, quality control of imaging equipment, regulations, licensing and health physics program design.

53. BME 568 BioMEMS, Prerequisite: BME 460, (3 Cr. Hrs.)

introduction to micromachining processes used to construct MEMS. Coverage of many lithographic, deposition, and etching processes, as well as their combination in process integration. Materials issues such as chemical resistance, corrosion, mechanical properties, and residual/intrinsic stress. Introduction to MEMS design. Design methods, design rules, sensing and actuation mechanisms, microsensors, and microactuators. Designing MEMS to be produced with both foundry and nonfoundry processes. Computer-aided design for MEMS. Micro- and nanosystems used in advanced analytical techniques for microfluidic devices, implantable chips, non-invasive biomedical sensors, DNA chips and microelectronic array systems. Microelectronic processing design for micromaching and piezoelectric materials for biomedical applications. Biomedical sensors and actuators. BioMEMS active ultrasonic transducers for medical imaging, for micro-valves and for implantable medication delivery systems are studied.

54. BME 570 Bioengineering Design Concept, Prerequisite:BME 300,(3 Cr. Hrs.)

Design of a device, circuit system, process, or algorithm. Team solution to an engineering design problem, from initial concepts through evaluation and documentation. Develop instrumentation standards and construction techniques for

biomedical equipment. Design the documentation and hardware for a biomedical instrumentation system. Use commercial instrumentation systems for analysis and testing. Principles and practice of medical instrumentation. Instrument components and medical instrument systems design. Examples will be taken from electrocardiography, clinical chemistry, medical imaging. Microprocessor-based systems emphasized.

55. BME 572 Medical Systems & Environment Safety, Prerequisite: BME 460, (3 Cr. Hrs.)

Extensive study of established safety standards, insuring proper patient, personal, and environmental safety. Inclusive are requirements for testing, monitoring, and recording safety procedures subsequent to governmental and industry standards. Provide applications of safety, calibration and troubleshooting techniques to practical situations. Mutual visits to hospital environment to gain onsite practical safety experience.

56. BME 574 BioMechanics II, Prerequisite: BME 300, (3 Cr. Hrs.)

Study of kinematics and kinetics of human movement, including electromyography, fluid and tissue mechanics with applications.

57. BME 576 BioMaterials, Prerequisite: BME 300, (3 Cr. Hrs.)

The engineering characteristics of materials, including metals, ceramics, polymers, composites, coatings, and adhesives, that are used in the human body. Emphasizes the need of materials that are considered for implants to meet the material requirements specified for the device application (e.g., strength, modulus, fatigue and corrosion resistance, conductivity) and to be compatible with the biological environment (e.g., nontoxic, noncarcinogenic, resistant to blood clotting if in the cardiovascular system).

58. BME 596 A Special Topics, Prerequisite: department's directions, (3 CR. Hrs.)

The contents of the special topic course will be in the field of biomedical systems and different from the contents of the offered courses. It will be determined by the department.

59. BME 598A: Graduation Project, Prerequisite: BME 498A (3 Cr. Hrs.)

Theoretical investigation and practical implementation of special projects in the fields of Biomedical Engineering will be supervised by an academic member of the faculty. The project is a continuation of BME 498A. Periodic reports and a final report must be submitted for evaluation, an oral examination is required.

DEPARTMENT REQUIREMENTS (116 CR.)

1. Biomedical Informatics Engineering Compulsory Requirements (104 Cr.)

Course No.	Course Title	No. of Hours			Prerequisites
		Theory	Practical	Credit	
Bio 108	Human Biology	3	-	3	-
BME 102	PathoPhisology I	3	-	3	Bio 108
BME 105	PathoPhisology Lab.	-	3	1	BME 102
BME 200	Introduction to Medical Informatics	3	-	3	CS 101
EPE 200	Engineering mechanics	3	-	3	PHY 101
BME 202	Introduction to Cybernetics	3	-	3	Math 203
STAT 203	Biostatistics	3	-	3	Bio. 102 or Geo 102 or BME 102
BME 204	Introduction to Biomedical Systems Engineering	3	0	3	BME 202
BME 205	Software tools for Biomedical Systems Lab.	0	3	1	BME 204*
EPE 220	Electrical Circuits I	3	-	3	PHY 102
EPE 223	Electrical Circuits Lab.	-	3	1	EPE 220
CPE 250B	Object Oriented Programming	3	3	4	CS 101
CPE 250L	Object Oriented Programming lab.	0	3	0	-------
ELE 250	Electronics I	3	-	3	EPE 220
ELE 251	Electronics I Lab.	-	3	1	ELE 250
BME 300	Biomechanics I	3	0	3	EPE 200
CME 312B	Signals & Systems	3	0	3	EPE 220
CpE 352	Software Engineering	3	0	3	CpE 250
CpE 354A	Algorithms & DataStructures	3	3	4	CpE 250
CpE 354L	Algorithms & DataStructures Lab.	0	3	-	---------
BME 356	Medical Electronics	3	-	3	ELE 250

BME 357	Medical Electronics Lab.	-	3	1	BME 356
MIS 361	Software Project Management	3	-	3	-
BME 366	Programmable Circuits & Microcontrollers	3	0	3	BME 356
BME 367	Programmable Circuits & Microcontrollers Lab.	0	3	1	BME 366
BME 380	Medical Transducers	3	0	3	BME 356
BME 390	Biomedical Signal Processing	3	0	3	CME 312B
BME 391	Biomedical Signal Processing Lab.	0	3	1	BME 390
BME 396	BioFluids	3	0	3	EPE 200
BME 400	Ethics in Biomedical Engineering	1	0	1	BME 204
BME 420	Medical Instrumentation	3	0	3	BME 380
BME 421	Medical Instrumentation lab	1	3	1	BME 420
BME 422	Concepts of Medical Imaging	3	0	3	BME 380
BME 430	BioInformatics I	3	0	3	BME 102 & CpE 450B
BME 431	BioInformatics Lab.	0	3	1	BME 430*
BME 433	Applications of BioInformatics Lab.	0	3	1	BME 431
BME 435	Clinical Data Encoding Lab.	0	3	1	CpE 354A
BME 440	e-Health	3	0	3	BME 420
CpE 450B	Information Systems & Database	3	3	4	CpE 250B
CpE 450L	Information Systems & Database Lab.	0	3	0	----
ELE 455	Specialized Measurements lab.	0	3	1	BME380

BME 498B	Primary Graduation Project	0	3	1	Department Decision
BME 500B	Field Training in Medical Informatics	Six Months		9	Department Decision
BME 598B	Secondary Graduation Project	0	6	3	BME 498B

***Co requisite course, i.e., can be taken together**

5. Biomedical Informatics Engineering Optional Requirements (12 Cr.)

Course No.	Course Title	No. of Hours			Prerequisites
		Theory	Practical	Credit	
BME 104	PathoPhisology II	3	-	3	BME102
BME446	Pattern Recognition & Decision Making	3	0	3	BME390
BME464	Advanced Biomedical Signal Processing	3	0	3	BME390
CIS 467	Data Mining	3	0	3	BME 430 or CIS 260
BME530	BioInformatics II	3	0	3	BME430
BME532	Management in Health Care systems	3	0	3	MIS 361
BME534	Computational Biology	3	0	3	BME430
BME540	Networks in health care systems	3	0	3	BME440
BME542	Safety & Security of health Information system	3	0	3	BME440
BME544	Medical Image Processing.	3	0	3	BME390
BME596B	Special Topics	3	0	3	Department Decision

***Co requisite course, i.e., can be taken together**

COURSE DESCRIPTION (COLLEGE REQUIREMENTS**)**

1. CS101: Programming In A Selected Language (3 Cr. Hrs.)

It covers the basic concepts, properties, data representation, and syntax of a selected programming language. Students will learn how to use the structured programming approach. The course also covers the foundations of object-oriented programming.

2. Math. 101 - Calculus (1) (3 Cr. Hrs.)

Limits, continuity, and derivative: Tangent and normal lines, local extrema, concavity. Related rates. Vertical and horizontal asymptotes. The mean value theorem of differentiation and its applications. The definite integral, the fundamental theorem of calculus, the indefinite integral. Applications of the definite integral: Area, solids of revolutions, volumes using cylindrical shells, arc length. The transcendental functions: The general exponential and Logarithmic functions. The hyperbolic functions, the inverse function of the trigonometric and hyperbolic function.

3. Math. 102 - Calculus (2) (3 Cr. Hrs.)

Techniques of integration: Integration by parts, trigonometric substitutions, partial fractions, quadratic expressions. The conic sections. Plane curves and polar coordinates: Parametric equations, tangent lines, area in polar coordinates, surface of revolution. Indeterminate forms and improper integrals. Sequences and infinite series: convergence and divergence, positive term series, alternating series, absolute and conditional convergence. Power series: Differentiation and integration, Taylor series.

4. MATH. 203 - Ordinary Differential Equations (1) (3 Cr. Hrs.)

Introduction and classification, solutions of first order differential equations and their applications, (Growth and decay problems and linear motion problems). Solutions of higher order linear differential equations and their applications (Spring problem and projectile problems). Series solutions of differential equations near ordinary points. Solution of ordinary differential equations by Laplace transforms.

5. PHYS 101 - General Physics (1) (Mechanics) (3 Cr. Hrs.)

Measurement and system of units, Vectors, Motion in one and two dimensions, Particle dynamics and Newton's laws of motion, Work and energy, Conservation of energy, Dynamics of system of particles, Center of mass, Conservation of linear momentum, Collisions, Impulse, Rotational Kinematics, Rotational Dynamics, Conservation of angular momentum, Elasticity, Gravity, Fluids.

6. PHYS 102 - General Physics (2) (Electricity and Magnetism) (3 Cr. Hrs.)

Charge and matter, Electric field, Gauss's law, Electric potential, capacitors and dielectrics, current and resistance, electromotive force and circuits, the magnetic field,

Ampere's law, Faraday's law of induction, Maxwell's equations; magnetic properties of matter, A.C circuits.

7. PHYS 105 - General Physics Laboratory (1) (Mechanics) (1 Cr. Hr.)

12 experiments covering the topics discussed in physics 101.

8. PYHS 106 General Physics, Lab. (2) (Electricity and Magnetism) (1 Cr. Hr.)

12 experiments covering the topics discussed in physics 102.

9. Chemistry 101 : General Chemistry I. (3 Cr. Hrs.)

Scientific Measurements, Stoichiometry, Chemical reactions, Atomic Structure, Molecular Structure, Periodic Table, Chemical Bonding, Gases and their Laws, States of Matter and Forces among Molecules.

10. General Chemistry Lab. (I) (1 Cr. Hrs.)

Lab. Safety and Basic Lab. Techniques, Formula of Hydrate, Empirical Formula of a Compound, Limiting Reactant, Periodic Chart and Periodic Law, Spectroscopy and Molecular Geometry, Properties of Inorganic Compounds and Metathesis Reactions, Molecular Weight of a Volatile Liquid, Preparation of an Alum, Aspirin Synthesis, Standardization of NaOH solution; Equivalent Weight of an Acid, Colligative Properties (FW Determination).

DEPARTMENT REQUIREMENTS:

1. **Bio 108 Human Biology (3 cr. Hrs)**

Survey of human body structure and function. Starting at biological macro-molecules, levels of organization, cells, tissues and ending at the level of human body systems (skeletal, muscular, nervous, cardiovascular, respiratory and digestive systems). Topics include human inheritance (from chromosomes to biotechnology), human reproduction (male and female anatomy and physiology), fetal development and birth. On modular basis, students will be introduced to techniques and machinery applied in medicine for diagnostic procedures. ECG, EMG, EEG, Blood testers, ..etc.

2. BME 102 PathoPhysiology I, Prerequisite: Bio 108 (3 cr. Hrs)

Covers the physiology and basic mechanisms of diseases and selected common disorders of the following systems: cardiovascular, cardiac diseases, Hypertension, Coagulation disorders, Atherosclerosis, Aneurysms and Dissections of blood vessels, Heart Failure, Ischemic Heart diseases, Valvular Heart diseases; respiratory, Bronchial asthma, Chronic obstructive pulmonary disease**,** Bronchitis and

bronchiactasis, Respiratory failure; hematopoeitic, Red blood cell disorders, White blood cell disorders, Platelet disorders; renal system, reneal diseases, renal failure.

3. BME 104 pathophysiology II, Prerequisite: BME102, (3 Cr. Hrs.)

It includes the physiology and basic mechanisms of diseases and selected common disorders of the following systems: gastrointestinal and hepatobiliary, genital, endocrine, musculoskeletal, and nervous systems.

4. BME 105 PathoPhisology Lab. Prerequisite: BME 102 (1 cr. Hr)

The lab will cover the fundamental concepts of human physiology and its pathology. It includes experiments that covers the following topics: Cells and tissues, Diffusion, osmosis, and tonicity, Enzymes, Nervous System, Special Senses, Endocrine glands, Skeletal muscle, Blood, The Heart, Blood Flow, Blood Pressure, and ECGs, Respiration, Digestion, and Renal (Urinary) System. Furthermore, clinical workflows and the related information processes will be studied.

5. BME 200 Introduction to Medical Informatics Prerequisite : CS 101 (3 cr. Hrs)

Introduction to health care Information systems and its applications. Locating, manipulating, and displaying information in health care settings. Medical records and hospital and patient information handling. Both conventional and proposed patient and hospital information systems will be discussed as well as the impact of governmental, state and local regulations on the security and transfer of medical information. Experiences with information and workflow in a hospital as well as with organizational aspects are necessary for teaching this course.

6. EPE 200 Engineering Mechanics, Prerequisite: PHY 101 (3 Cr. Hrs)

Force analysis, equilibrium of particles, moment of forces, vector products, moment of couple. Reactions and supports. Equilibrium of rigid bodies. Truss analysis. Kinematics of rigid bodies. Plane motion of rigid bodies (force, acceleration, energy and momentum).

7. BME 202 Introduction to Cybernetics Prerequisite: Math 203 (3 Cr. Hrs)

Cybernetic systems in biology, basic components and structures of control systems, automatic control, systems analysis, control theory, dynamics of feedback systems quantitative description of linear systems, examples of biological control systems, examples for reception, transmission, and processing of information by receptors and neurons, and neural networks.

8. STAT 203 Biostatistics (Geology and Biology Students), Prerequisite: Bio. 102 or Geo 102 or Bio 108 (3 Cr. Hrs)

Collecting samples. Tables and graphical representation of the geological and biological data. Probability and its properties. Point and interval estimation, testing hypothesis. Categorical data. Linear regression and correlations. Biostatistics. Analysis of real data.

9. BME 204 Introduction to Biomedical Systems Engineering, Prerequisite: BME 202 (3 Cr. Hrs)

Introduces the interdisciplinary nature of the Biomedical Engineering Technology program through engineering and medical terminology. Presents hospital and industrial policies, procedures and codes with an emphasis on safety. Introduces biomedical instrumentation, control systems and the man-machine interface. Introduces techniques for analysis and modeling of biomedical systems. Application of mathematics (including Differential Equations, Laplace Transforms and Statistics) and computer-aided methods to study problems at the interface of engineering and biology. Elements of physiological modeling and the solution of the transient and forced response for a variety of biomechanical, biomaterial, bioelectrical and biochemical systems.

10.BME 205 Software tools for Biomedical Systems Lab, co-requisite BME 204, (1 Cr. Hr.)

Introduces state of the art software packages that will be applied to simulate and model problems at the interface of engineering and biology. Apply mathematical techniques on biomedical informatics engineering problems including numerical methods, equation solutions, curve fitting and approximation etc.

11. EPE 220 Electrical Circuits I, Prerequisite: PHY 102 (3 Cr. Hrs)

System of units, circuit variables (charge, current, voltage, power, energy). Circuit elements, and simple resistive circuits. Techniques of circuit analysis. The ideal operational amplifier, inductance and capacitance. Natural and step responses of first order RL and RC circuits. Natural and step responses of RLC circuits.

12. EPE 223 Electrical Circuits II, Co-requisite: EPE 220 (1 Cr. Hrs)

Measuring devices (Ammeter, Voltmeter, Oscilloscope), DC circuit analysis (Ohm`s law, KCL, KVL, current division, voltage division, series/parallel combinations of resistors, wheatstone bridge, Thevenin`s and Norton`s equivalent circuits, maximum power transfer), RLC components and their frequency dependence, frequency resonance of RL and RC Circuits, phase measurements using the oscilloscope, series

sinusoidal circuits, parallel sinusoidal circuits, series-parallel sinusoidal circuits, Thevenin`s theorem and maximum power transfer, resonant circuits, frequency response of filters (low-pass, high-pass, Band-pass).

13. CPE 250 Object Oriented Programming, Pre-requisite: CS 101, (3 Cr. Hrs.)

Overview of C++, C#, and java, Object Oriented Programming methodologies, Classes and data abstraction, Constructors and destructors, Operator Overloading and conversions, Subclasses and Inheritance, Virtual functions and polymorphism, Templates and Exception handling.

14. CPE 250 L Object Oriented Programming Lab., Co-requisite: CPE 250, (1 Cr. Hr.)

This lab will provide hands on experience on theoretical topics of object oriented programming in a comprehensive application.

15. ELE 250 Electronics I, Prerequisite: EPE 220 (3 CR. Hrs.)

P-N junction diodes, diode applications (rectification, regulation, clipper, voltage multipliers), bipolar junction transistor (construction, operation, biasing and stability, DC and AC modeling of BJT, design of CB, CE and CC amplifiers), field effect transistor (construction, operation, JFET, MOSFETS, AC modeling of JFET, design of FET amplifiers, CS, CD, CG amplifiers), transistors as switches.

16. ELE 251 Electronics I Lab., co-requisite ELE 250, (1 Cr. Hr.)

Diode characteristics, Zener diode, small and large signal diode circuits, rectification and regulation circuits, clippers, clampers, voltage multipliers, BJT characteristics (CB, CE and CC), BJT and JFET AC- parameters, biasing of BJT and JFET circuits, BJT- amplifiers, JFET- amplifiers.

17. BME300 Biomechanics I, Prerequisite: EPE 200, (3 Cr. Hrs.)

Fundamental mechanical principles will be reviewed, with subsequent application to the major joints and structures of various regions of the human body, and the integration of biomechanics with other exercise and sport science disciplines. An introduction to the structure and mechanics of the musculoskeletal system and to the properties and strength of biological materials, application of Newtonian mechanics, statics, and strength of materials to bone, muscle, tendon, and other biological material.

18. CME 312B Signals and Linear Systems, Prerequisite: EPE220. (3 Cr. Hrs.)

Continuous and discrete time signals and systems, continuous and discrete time convolution, continuous and discrete LTI systems, Fourier analysis for continuous-time signals, properties and applications of Fourier transform, Laplace transform and z-transform. Filter design techniques.

19. CpE 352 Software Engineering Prerequsite: CpE250B, (3 Cr. Hrs.)

Importance of software, software engineering definition, software life cycle, stages of software development process, requirement analysis: principles, specifications, methods, tools, design fundamentals: design process concept, top-down design, structured programming, modularity, design tools, validation, design methods, coding: choice of a programming language, coding style, efficiency, testing: stages strategies and tools, debugging maintenance: characteristics and tools standards**.**

20. CpE 354 A Algorithms & DataStructures,Prerequisite: CpE 250B, (4 Cr. Hrs.)

Abstract data types and structures, static versus dynamic memory allocation, sorting algorithms, searching algorithms, arrays, linked lists, queues, stacks, different types of trees, hashing and hash tables, and recursion.

21. CpE 354 L Algorithms & DataStructures,Co-requisite: CpE 354A, (0 Cr. Hrs.)

Experiments on the different theoretical topics of algorithms and DataStructures course. Development and implementation of (recursive) algorithms e.g. search, sorting algorithms and graph algorithms; Implementation of the most common data structures (different types of lists and trees) in the context of the development of small applications; Comparison of the operating time of different algorithms for one specific problem.

22. BME 356 Medical Electronics, Prerequisite: ELE 250, (3 Cr. Hrs.)

Multistage amplifiers, Frequency response, Power Amplifiers, Operational Amplifiers, special amplifiers (differential amplifier, Instrumentation amplifier, etc), functional integrated circuits (V/f converters, A/D converters, etc), Active Filters.

23. BME 357 Medical electronics Lab, Co-requisite: BME 356, (1 Cr. Hr.)

Multistage amplifiers, Power Amplifiers, Differential Amplifiers, Instrumentation Amplifier, Special circuits (V/f converters, f/V converter, Log-Amplifiers, etc), Active Filters: low-pass, high-pass, band-pass and band-stop filters.

24. MIS 361 Software Project Management, (3 Cr. Hrs.)

An introduction to the fundamental concepts of team based project management and use of information technology resources to develop information systems. Presents the technical, managerial, and organizational concepts and tactics associated with managing software development and/or acquisition projects.

25. BME 366 Programmable Circuits & Microcontrollers, Prerequisite: BME 356, (3 Cr. Hrs.)

Analysis and design of digital circuits (combinational and sequential), A/D and D/A converter, digital design with hardware-programmable, digital design using VHDL, microprocessors, microcontrollers and picocontrollers, DSP devices.

26. BME 367 Programmable Circuits & Microcontrollers Lab., Co-requisite: BME 366, (1 Cr. Hrs.)

Experiments that handle different applications of digital electronic circuits and microcontrollers.

27. BME 380 Medical Transducers, Prerequisite: BME 356, (3 Cr. Hrs.)

Theory and principles of biosensor design and application in medicine and biology. Analysis and selection of physical, optical, electrical, mechanical, thermal transduction mechanisms, which form the basis of the biosensor design. Principles and fundamental properties of transducers (dynamics, linearity, hysteresis, and frequency range). Blood flow and volume measurement, temperature measurement, muscle contraction transducers, biopotential measurements, radioactive sensors, optical fiber sensors, electrochemical and optical sensors, oxygen sensors.

28. BME 390 Biomedical Signal Processing, Prerequisite: CME 312, (3 Cr. Hrs.)

Acquisition and sampling of biosignals; Shannon's Theorem; continuous and discrete time signals, z-transform, FIR and IIR filters, Fourier series and Fourier transform, power spectrum estimation, filter techniques for modeling biomedical signals, noise removal and signal compensation. Introduction to computer aided ECG processing, EEG-processing in the time and frequency domain; signal averaging of EP's.

29. BME 391 Biomedical Signal Processing Lab., Co-requisite: BME 390 (1 Cr. Hr.)

Origin, description and characteristics of biomedical signals. Reduction of interferences. Digital Filters (FIR filters, IIR filters, integer filters). Temporal analysis. Spectral analysis. Compression of biomedical signals. Introduction to time-frequency analysis.

30. BME 396 BioFluids, Prerequisite: EPE 200, (3 CR. Hrs.)

This course covers the Geometry and Electrical system of the heart. Circulatory Biofluid mechanics, Blood rheology, Newtonian and non-Newtonian fluid mechanics. Pulsatile flow, vortex control of valve motion, and regurgitation. The thixotropic nature of blood. Shear-rate and time-dependent viscosity of blood. Other biological

fluids such as mucous and spinal fluid will also be covered. Overview of airway flow in the lung and the effects of aerosols.

31. BME 400 Ethics in Biomedical Engineering, Prerequisite: BME 204, (1 CR. Hr.)

This course introduces the wide spectrum of ethical, regulatory, and legal issues facing health care practitioners and biomedical engineers. Lectures and discussions help students become aware of the ethical and legal issues involved in their work. The course introduces students to the processes involved in making ethical and legal decisions in matters related to human health and biomedical research. Students are also provided with several sources of additional help and guidance for further investigation and analysis.

32. BME 420 Medical Instrumentation, Prerequisite: BME 380, (3 Cr. Hrs.)

Noise sources and noise reduction techniques, Bioamplifiers and signal conditioning grounding and shielding techniques, electrical safety and basic concepts of biosensor, biomedical instrumentation, basic theories of measurements, cardiovascular measurements. Patient care and monitoring, measurements in the respiratory system, noninvasive diagnostic instrumentation.

33. BME 421 Medical Instrumentation lab., Co-requisite: BME 420, (1 Cr. Hrs.)

Principles of Electrodes, transducers, noise, precision, aliasing, Nyquist theorem, sampling, the hardware and instrumentation needed to measure variables from different physiological systems. Bioelectric amplifiers and biomedical signal conditioning. Hardware for measurement of the ECG, EEG, EMG, respiratory system, nervous system. Clinical laboratory instruments and Electrical safety.

34. BME 422 Concepts of Medical Imaging, Prerequisite: BME 380, (3 Cr. Hrs.)

Diagnostic Ultrasound Imaging, Magnetic Resonance Imaging (MRI), Radiographic Imaging Systems, Emission Imaging systems, Comparison of Imaging modes.

35. BME 430 BioInformatics I, Prerequisite: BME 102, (3 Cr. Hrs.)

Introduction to *Bioinformatics*, principles and computational methods for organizing and maintaining large volume of genomic data. Genome sequencing projects, proteomics and gene expression studies. Fundamentals theories will be presented to define the modeling philosophy and principles as well as simulation methodologies for the integration of genomic and physiological data in the analysis of complex biological processes and for diagnostic matters.

36. BME 431 BioInformatics Lab., Co-requisite: BME 430, (1 Cr. Hrs.)

Fundamental training and development of biological, mathematical and algorithmic models underlying bioinformatics; Basics of Molecular Biology (3 experiments), Intro to Sequence Similarity Testing / Pairwise Sequence Alignment (3 experiments), Multiple Sequence Alignment (2 experiments), Intro to Phylogenetic Tree Reconstruction, Phylogeny 2: Parsimony , and Phylogeny 3: Maximum Likelihood .

37. BME 433 Applications of BioInformatics Lab., pre-requisite: BME 431, (1 Cr. Hrs.)

RNA Secondary Structure Prediction (2 experiments) , Protein Structure (2 experiments), Gene Finding (2 experiments), Gene Expression Analysis (2 experiments) Intro to DNA Computation, Survey of Design of DNA molecules.

38. BME 435 Clinical Data Encoding Lab., Co-requisite: BME 431, (1 Cr. Hrs.)

This Lab is designed to help students learn the basics of HL7 (Health Level Seven) and to understand how it fits within the healthcare workflow, including how it integrates with DICOM. It is also designed to help them learn the essentials of DICOM. Students will be able to read and understand what's in a DICOM Conformance Statement by the end of the course plus an understanding of the most important DICOM terms

39. BME 440 e-Health, Prerequisite: BME 420, (3 Cr. Hrs.)

Internet based healthcare delivery systems, conventional and novel telemedicine systems, remote consultation systems and their use in clinical decision making process; tele-surgery, tele-pathology concepts, use of e-health by public health agencies; e-commerce in healthcare, planning, developing, and maintaining Web sites and supporting information systems. Business processes, online payments and international legal, privacy and security issues.

40. BME 446 Pattern Recognition & Decision Making, Prerequisite: BME390, (3 Cr. Hrs.)

Overview of issues related to medical decision making. Introduction to concept of evidence-based medicine and decision processes related to process of care and outcomes. Basic probability and statistics to understand research results and evaluations, and algorithmic methods for decision-making processes (Bayes theorem, decision trees, neural networks, and fuzzy methods). Study design, hypothesis testing, and estimation. Technical advances in medical decision support systems and expert systems, review of classic and current research. Introduction to common statistical and decision-making software packages to familiarize students with current tools.

41. CpE450B Information Systems & Database, Prerequisite: CpE 250, (4 Cr. Hrs.)

Introduction and History, DBMS Architecture, Storage Hierarchy, Indexes, Entityrelationship (E-R) modeling, The relational model, Relational Query Language (SQL), Query processing and optimization, Transaction Processing (Transactional properties, Concurrency control, Locking, and Crash recovery), introduction to distributed databases. Required software tools: A main-stream commercial DBMS such as SQL 2000 or Oracle. Individual projects are given for the students to sharpen their database development skills using latest software tools and concepts.

42. CpE450L Information Systems & Database, Co-requisite: CpE 450B, (0 Cr. Hr.)

Hands on experience related to the main topics covered by CpE450B.

43. ELE 455 - Specialized Measurements Lab., Prerequisite: ELE 404 or BME 380, (1 Cr. Hr.)

Displacement and angular measurements, liquid flow measurements, PH, humidity, and conductivity measurements, pressure measurements, thermal sensors and its measurements, velocity measurements, optical transducers, spectrum analyzer (analysis and system identification), project.

44. BME464 Advanced Biomedical Signal Processing, Prerequisite: BME390, (3 Cr. Hrs.)

Parametric modeling, modern spectral estimation, multivariate analysis, adaptive signal processing, decimation/interpolation, wavelets, and two-dimensional signal analysis. Principal component analysis, Independent component analysis (ICA), Nonlinear methods. There will be several computer projects, which apply these modern techniques to physiologic data.

45. CIS 467 Data Mining Prerequisite: CIS 260 or BME430, (3 Cr. Hrs.)

Knowledge discovery fundamentals, data mining concepts and functions, data pre-processing, data reduction, mining association rules in large databases, classification and prediction techniques, clustering analysis algorithms, data visualization, mining complex types of data (text mining, multimedia mining, Web mining … etc), data mining languages, data mining applications and new trends.

46. BME 498B Graduation Pre-Project Prerequisite: directed by the department, (1 Cr. Hr.)

Theoretical investigation and problem identification of a special project in medical informatics or bioinformatics under the supervision of an academic faculty member, detailed report as well as an oral examination are required.

47. BME 500B Field Training, Prerequisite: directed by the department, (9 Cr. Hrs.)

A training period of six month to be spent in the medical informatics or bioinformatics industry or research centers (inside or outside Jordan), under the follow up of an academic faculty member from the department, periodic reports and a final report must be submitted for evaluation, an oral examination is required.

48. BME 530 BioInformatics II, Prerequisite: BME 430, (3 Cr. Hrs.)

Apply fundamental bioinformatics methods to analyze protein sequence and structure data, genomic DNA sequence, and gene expression data. Interpret and evaluate results of key bioinformatics analyses; System biology focusing on the development of models on molecular and tissue level. . Design effective strategies for application of bioinformatics methods, including appropriate controls and/or significance tests. Combine fundamental methods into multi-part strategies for addressing complex problems.

49. BME 532 Management in Health Care Systems, Prerequisite: MIS 361, (3 Cr. Hrs.)

Principles of health information management. admitting procedures, analysis of the medical records, organizing health information systems, statistics and legal aspects of medical records services. Acquisition and maintenance of health care data. Develop knowledge in the areas of numbering, filing, indices, registers, record retention, storage and retrieval systems, microfilming and optical disk storage. Billing office procedures and basic computerization in the health information management department, including the keyless data entry techniques for bar coding, smart cards, voice recognition, magnetic strip, touch screens, electronic data interchange, and optical character recognition.

50. BME 534 Computational Biology, Prerequisite: BME 430, (3 Cr. Hrs.)

Computational modeling focuses on modeling and analysis of biological systems. The multiscale modelling of biological systems, using mathematical models and computer tools. Modelling strategies. Compartmental models of physiologic systems. Cellular models, organ models, systems models. Methods and tools for identification. Analysis of molecular biology databases, sequence analysis, modeling of regulatory networks and metabolic pathways. Examples will be discussed from systems biology and biomedical applications.

51. BME 540 Networks in Health Care Systems, Prerequisite: BME 440, (3 Cr. Hrs.)

Telecommunication concepts necessary for understanding network design and operation both within and between health care organizations. Topics include network designs (topology), client-server and mainframe environments, the operation of various network hardware devices (servers, routers, gateways, modems, cable types, etc.), network operating systems (NT, W2000, Unix, etc.), network protocols in health care (HL7, DICOM) and other network applications. Investigate processes, procedures and considerations for creating reliable computer networks. The understanding of telecommunications concepts is essential for teaming with technical professionals.

52. BME 542 Safety & Security of Health Information System, Prerequisite: BME 440, (3 Cr. Hrs.)

Extensive study of established safety standards, insuring proper patient, personal, and environmental safety. Inclusive are requirements for testing, monitoring, and recording safety procedures subsequent to governmental and industry medical standards. Comprehensive overview of the security, privacy and intrusion detection of health care networks. Health care network Defense and Countermeasures. Health care network encryption crypto-graphical methods, electronic signature, and authentication tools.

53. BME 544 Medical Image Processing, Prerequisite: BME 390, (3 Cr. Hrs.)

Fundamental concepts of low and high level image processing algorithms used in medical image analysis (such as those that occur in MRI,CT,PET or SPECT imaging). A basic review of image acquisition, through low level processing to high level object extraction and recognition: Image enhancement, restoration, filtering, segmentation, morphology, texture, presentation & description, compression, recognition & interpretation, and registration. These topics will be demonstrated throughout projects.

54. BME 596 B Special Topics, Prerequisite: department's directions, (3 CR. Hrs.)

The contents of the special topic course will be in the filed of medical informatics or bioinformatics and different from the contents of the offered courses. It will be determined by the department.

55. BME 598B: Graduation Project, Prerequisite: BME 498B (3 Cr. Hrs.)

Theoretical investigation and practical implementation of special projects in the fields of medical informatics or bioinformatics will be supervised by an academic member of the faculty. The project is a continuation of BME 498B. Periodic reports and a final report must be submitted for evaluation, an oral examination is required.