DEPARTMENT OF BIOMEDICAL ENGINEERING, MIT Manipal

M.Tech. BIOMEDICAL ENGINEERING

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
I	MAT 5151	Probability, Random Variables and Stochastic Processes	4	0	0	4	BME 5251	Basic Clinical Sciences	4	0	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	BME 5252	Medical Image Processing	4	0	0	4
	BME 5151	Advanced Biomedical Signal Processing Analysis and Modeling	4	0	0	4	BME ****	Elective I	4	0	0	4
	BME 5152	Biomechanics and Biodynamics	4	0	0	4	BME ****	Elective II	4	0	0	4
	BME 5153	Human Anatomy and Physiology	4	0	0	4	BME ****	Elective III	4	0	0	4
	BME 5154	Biomedical Instrumentation	4	0	0	4	*** ****	Open Elective	3	0	0	3
	BME 5161	Biomedical Instrumentation Lab	0	0	6	2	BME 5261	Biomechanics Lab	0	0	3	1
	BME 5162	Biomedical Signal Processing Lab	0	0	3	1	BME 5262	Medical Image Processing Lab	0	0	3	1
		Total	**21**	**0**	**12**	**25**		**Total**	**23**	**0**	**6**	**25**
II	THIRD AND FOURTH SEMESTER											
	BME 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
BME 5001	Biomaterials and Artificial Organs	BME 5006	Machine Learning
BME 5002	Cell Culture Techniques and Stem Cell Biology	BME 5007	Pattern Recognition
BME 5003	Data Communication and Networking in Healthcare Applications	BME 5008	Performance Modelling of Systems
BME 5004	Embedded Systems	BME 5009	Tissue Engineering
BME 5005	Experimental Techniques in Biomedical Research		

OPEN ELECTIVES			
BME 5051	Physiological Control Systems		

SEMESTER I

MAT 5151 PROBABILITY RANDOM VARIABLE AND STOCHASTIC PROCESSES [4 0 0 4]

Random Sampling, Sampling distributions, Parameter Estimation and Hypothesis Testing, Regression, Correlation and Analysis of Variance - Examples. Static probabilities: review and prerequisites generating functions, difference equations. Dynamic probability: definition and description with examples. Markov chains, transition probabilities, Chapmen Kolmogrov equations. Classification of states, chains of Markov process. Stability of Markov systems, limiting behaviour, random walk. Poisson Processes: assumptions and derivations, related distributions, birth and death processes. Queuing System, general concepts, Model M/M/1 and M/M/S, steady state behavior, transient behaviour.

Reference Books:

1. Hogg & Craig (1975), "Introduction to Mathematical Statistics", 4thEdn., MacMillan,
2. J. Medhi, "Stochastic Processes".
3. A. Papoulis and S.U. Pillai, Probability, Random Variables and Stochastic Processes, McGraw Hill, 2002.
4. P. Z. Peebles Jr., Probability, Random Variables and Random Signal Principles, McGraw Hill International Edition, 2001, Singapore.

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL COMMUNICATION [1 0 3 2]

Mechanics of Research Methodology: Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications. Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis. Thesis Writing and Journal Publication: thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

References

1. Dr Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo & David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004.
3. John W. Creswel, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE, 2004
4. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006.
5. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International Publisher, 2008.

BME 5151 ADVANCED BIOMEDICAL SIGNAL PROCESSING ANALYSIS AND MODELING [4 0 0 4]

Time domain and frequency domain Filtering techniques for Removal of artifacts, Event Detection in Biomedical signals, Cross-Correlation and Coherence Analysis, Frequency-domain Analysis for Spectral Estimation. Short Time Fourier Transform analysis and Wavelet Transform analysis, Multichannel Signals Analysis, Principal Component and Independent Component Analysis, Regressive and Stochastic Modeling techniques for Biomedical systems.

References:

1. Proakis J G and Manolakis D G, Digital Signal Processing: Principles, Algorithms, and Applications, 3rd edition, Prentice Hall, 2002.
2. Rangaraj M Rangayyan, "Biomedical Signal Analysis - A case study", John Wiley and Sons, Singapore, 2002.
3. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", Wiley student edition, 2009.
4. Cohen, L. Time-Frequency Analysis: Theory and Applications. 1st edition, Prentice Hall, 1994.
5. Hlawatsch, F and F. Auger. Time Frequency Analysis: Concepts and Methods. 1 edition, Wiley-ISTE, 2008.

BME 5152 BIOMECHANICS AND BIODYNAMICS [4 0 0 4]

Anatomical movement descriptors, biomechanical principles of human movement, skeletal considerations for movement, muscular considerations for movement, fundamental concepts of gait, linear kinematics, angular kinematics, linear kinetics, angular kinetics, application of aerodynamics in sports application of hydrodynamics in aquatics.

References:

1. Joseph Hamill and Kathleen M. Knutzen, Biomechanical Basis of Human Movement, Lippincott Williams & Wilkins, Third Edition, 2008, Philadelphia.
2. Ellen Kreighbaum, Katharine M Barthels, Biomechanics-A Qualitative Approach for studying Human Movement, Allyn and Bacon Publishers, Fourth Edition, 1995, USA.
3. Susan J. Hall, Basic Biomechanics, McGraw-Hill International Editions, Fifth Edition, 2006, Singapore.

BME 5153 HUMAN ANATOMY & PHYSIOLOGY [4 0 0 4]

PART - A ANATOMY

Skeletal System: Types of bone, classification, Structure of bone, Blood supply, Cartilage: Type, Structure in brief, Joints: Classification, Structure of synovial joint, Major joints of the body. Muscle tissue: Types, Structure of skeletal muscle, Types of muscles, Brain: Parts, Brain stem, Ventricles, CSF, Meninges, Cranial nerves (names and functions only). Spinal cord: Gross features and structures, Spinal nerve, Nerve endings and receptors, Autonomic nervous system. Sensory system: Eye, Ear, Skin. Heart: Pericardium, Chambers, Blood supply Organs. Respiratory system: Parts, Trachea, Lungs. G I Tract: Parts, Stomach, Intestine, Liver, and Pancreas. Urinary system, Male and Female reproductive organs, and Endocrine glands.

References:

1. Sampath Madhyastha, "Manipal Manual of Anatomy", CBS Publishers & Distributors, Edition 3, 2016.

PART - B PHYSIOLOGY

Introductory lecture pertaining basic functional concept of the human body as a whole and contribution of the individual system. Hematology; Leverage system. Nerve action potential and its ionic basis. Body temperature regulation; Biophysical aspects of blood pressure (Bop) and its recording technique. Electrocardiograph and its gross normal features and alterations, Optics of the eye. Fundamental tonal analysis, determination of pitch, loudness and quality of sound. Sensorium -

general role of receptors as transducers, generation of potential in the receptors. Motor control of skilled voluntary movements: Mechanism of abnormal oscillatory movements Electroencephalogram and electrocorticogram.

References:

1. Charles E Tobin, "Manual of Human Dissection", McGraw Hill, Edition 4, 1961.
2. J Gibson, "Modern Physiology and Anatomy of Nurses", Black Well, 1981.
3. A J Vander, "J H Sherman, D S Luciano, Human Physiology", McGraw Hill, Edition 8, 2000.
4. Cyril A Keele, Eric Neil, Neil Norman Joels, "Samson's Wright's Applied Physiology", Oxford University Press, 1993.

BME 5154 BIOMEDICAL INSTRUMENTATION [4 0 0 4]

Study of Bio-electric signals & Electrodes, Transducers, Blood pressure & Blood flow measurements. Study of Diathermy, Haemodialyser, Lithotriptor, Pulse Oximetry: Introduction, other methods to determine oxygen saturation of blood, major parts of pulse oximetry, applications of pulse oximetry. Anesthesia machine, Ventilator, Infusion pump, Infant Incubator; Study of Surgical devices: ESU, LASER & Endoscope. Cardiac-assist devices: Heart lung machine, Pacemaker & Defibrillator. Study of Ultrasonography and Thermography, Introduction to X-ray imaging, Magnetic Resonance Imaging, Single-photon emission computed tomography and Positron Emission Tomography

Reference Books:

1. R.S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, 1980.
2. Leslie Cromwell, "Bio Medical Instrumentation", PHI, 1990.
3. Geddes and Baker, "Principles of Applied Bio-Medical Instrumentation", John Wiley, 1989.
4. J.G. Webster," Medical Instrumentation, Application and Design" Houghton Miffin Co. Boston.

BME 5161 BIOMEDICAL INSTRUMENTATION LAB [0 0 6 2]

Study of the characteristics of Capacitive pickup transducer, Inductive pickup transducer, pressure cell, Strain sensor, RTD transducer, Linear Variable Differential Transformer (LVDT), Hall effect transducer, LDR / Phototransistor and photodiode, load cell, thermocouple, DC serve motor control, voltage to frequency converter; Realization of a Pacemaker circuit and Instrumentation amplifier.

Demonstration: Study of Electrocardiograph and determining the cardiac vector; study of Audiometer and Air conduction thresholds testing; study of Blood Pressure meter, Defibrillator, Electrosurgical unit (ESU), Phonocardiograph and to visualize the heart sounds. Design and implementation of circuits with biomedical applications like QRS detector, Hearing aids, Digital thermometer etc.

References:

1. R.S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, 1980.
2. Leslie Cromwell, "Bio Medical Instrumentation", PHI, 1990.

BME 5162 BIOMEDICAL SIGNAL PROCESSING LAB [0 0 3 1]

Introduction to MATLAB. Generation of sequences: Unit sample, unit step, real/complex exponential, sinusoidal; LSI systems: Investigation of linearity & time-invariance, Computation of impulse response, Convolution, Stability; Computing and plotting the frequency response from the transfer function/unit-sample response; pole-zero plot from the transfer function. DFT: Illustration of circular shift of a sequence, circular time-shifting & circular convolution property, linear convolution via circular convolution; Computation of the DFT / FFT of a 1D signal. Implementation of FIR and IIR filters. Power spectrum estimation: Periodogram & Welch's method. ECG: QRS detection, extracting the RRI series and calculation of heart rate; the utility of Auto correlation & Cross correlation for template matching. ECG signal compression using Turning Point algorithm & DCT.

References:

1. A.V. Oppenheim, A.S. Willsky and I.T. Young, "Signals and Systems", Pearson Education India; 2nd Edition (2015).
2. Ronald W. Schafer, Alan V. Oppenheim, Discrete-Time Signal Processing, PEARSON 3rd Edition, 2014.

Rangaraj M Rangayyan, "Biomedical Signal Analysis - A case study", John Wiley and Sons,Singapore, 2002.

SEMESTER II

BME 5251 BASIC CLINICAL SCIENCES [4 0 0 4]

PART-A PHYSIOTHERAPY

Physiology of pain and pain modulation, Pain reliving Modalities-Role of TENS, Interferential current therapy, Pain reliving modalities-II: Superficial Heating modalities, Short wave diathermy, Ultra sound, Laser, EMG, nerve conduction studies, Bio feedback and other diagnostic currents, Gait and gait analysis systems. Fitness, Cardiac and pulmonary rehabilitation- analysis and training instrumentation including Ergometer, Treadmill Evaluation methods: Concept of MMT, Dynamometer, Isokinetic, Esthisiometer, Goniometer, Instrumentation for different type of exercise: CPM, Hydrotherapy, Suspension. Introduction to Joint biomechanics with example of Knee and Hip Joint Orthotics and prosthesis, Practical Demonstration

References:

1. Gardiner M. Deena "The Principles of Exercise Therapy", CBS Publishers & Distributors, 2007
2. Sheila Ed. Kitchen, Sarah Ed. Bazin "Clayton's Electrotherapy"10th edition, Bailliere Tindall, 1996
3. Susan B. O'Sullivan PT, EdD, Thomas J. Schmitz PT, PhD George Fulk PT, PhD F.A Davis, "Physical Rehabilitation", 6th Edition, F A Davis Company, 2014

PART-B SPEECH & HEARING

Audiometers, Middle ear analyzer, Evoked potentials, OAE, hearing aids, Cochlear implants, ALD, Hearing aid analyzer, Electro Glotto graphy, AAC, Introduction to speech assessment, DSP, Assessment of voice and fluency, Voice and fluency therapy assessment, Artificial larynx, Spirometry, Speech synthesis, Practical demonstration.

References:

1. Community based Rehabilitation, ISBNO 0-7020-1941-0, Saunders, London, 1997.
2. A Nenfeldt and A Albrigt, "Disability and Self- directed employment", 1998.
3. Keele Cyril A, Eric Neil, "Samson Wright's applied Physiology", oxford University Press, 1993.

PART - C ORTHOPAEDICS

Bioengineering aspects of fracture management: Structure of bone-gross, Microscopic biochemical fractures: Types, Mechanism of injury, Normal Healing of Fractures, Treatment of fractures: General principles, The concepts of load bearing, load sharing and stress shielding by implants, Piezo electricity and electrical stimulation for bone healing, Bioengineering aspects of joint diseases, Structure of joints: Fibrous, Cartilaginous, Synovial, Lubrication of joints and the functions of articular cartilage, Degeneration of cartilage, Degenerative arthritis and Rheumatoid arthritis, Joint replacement, hip, knee, shoulder, small joints. Biomaterials: Gait analysis, Orthotics, Principles of tendon transfer, Bioengineering principles of amputation and prosthetics, Upper limb prosthesis, Lower limb prosthesis.

References:

1. Victor H Frankel and Margareta Nordin, "Basic Biomechanics of the skeletal system". Lea and Febiger, 1980.
2. M. Dena Gardiner, "The principles of exercise therapy", CBS press, Edition 4, 1985.

BME 5252 MEDICAL IMAGE PROCESSING [4 0 0 4]

Signals & systems in 1D & 2D; 2D DFT and its computation. Image perception the human vision system, psycho-visual experiments, monochrome vision model, temporal properties. Image compression the discrete cosine transform (DCT), properties, computation, practical compression algorithm. Image Enhancement: Point operations and Spatial filtering: linear filters & the median filter. Connected-component labeling. Medical Imaging: Imaging modalities; Computed tomography (CT): mathematical basis, the Radon transform & the central slice theorem; Image reconstruction from projections: The Direct Fourier Method, convolution back-projection (CBP), reconstruction from fan-beam projections; X-rays: utility, generation and detection; X-ray CT systems. Emission CT: principles, Positron emission tomography (PET); Magnetic resonance imaging: Principles of data-generation, resolving the tissues, resolving the spatial locations. Edge detection; Colour-image processing: Fundamentals, Colour Models, Biomedical Engineering Applications.

References:

1. R.C Gonzalez and R.E. Woods, Digital Image Processing, 2nd Ed., Pearson Education Inc., Eighth Indian Reprint, 2002.
2. Jae S. Lim, Two-dimensional Signal and Image Processing, Prentice-Hall, Englewood Cliffs, New Jersey, 1990.
3. A. K. Jain, Fundamentals of Digital Image Processing, Prentice-Hall, 1989, Fourth Indian Reprint.
4. A.C. Kak and M. Slaney, Principles of Computerized Tomographic Imaging, SIAM's Classics in Applied Mathematics, Philadelphia, SIAM, 2001.
5. Kline Jacob, Handbook of Biomedical Engineering, Academic Press, 1988.

BME 5261 BIOMECHANICS LAB [0 0 3 1]

Modelling and Simulation using Opensim, Measuring Kinetic parameters using Force Plate, 2D motion data acquisition and analysis using Kinovea, Introduction to 3D motion analysis.

References:

1. Joseph Hamill and Kathleen M. Knutzen, Biomechanical Basis of Human Movement, Lippincott Williams & Wilkins, Third Edition, 2008, Philadelphia.
2. Ellen Kreighbaum, Katharine M Barthels, Biomechanics-A Qualitative Approach for studying Human Movement, Allyn and Bacon Publishers, Fourth Edition, 1995, USA.

BME 5262 MEDICAL IMAGE PROCESSING LAB [0 0 3 1]

Image Processing - Display and simple manipulations: flipping, rotation, and scaling; Decimation & interpolation; Effects of thresholding; Bit-plane mapping. Histogram of an image; Contrast enhancement: Application of manually specified transforms, Contrast Stretching; Computation of the 2D DFT, 2D FFT. Image Filtering - Spatial domain techniques: Neighborhood averaging

Median Filtering; Frequency-domain techniques: High pass and low pass filtering. Edge detection: Sobel, Prewitt & Robert's operators. Image Compression using DCT. The Radon Transform (RT): The RT of the Shepp-Logan Phantom; The inverse RT and image reconstruction from projections; Effects of the number of projections. Implementation of CBP algorithm, Hough transform & Geometric transformations.

References:

1. Rafael C. Gonzalez, Richard Eugene Woods, Digital Image Processing using MATLAB, 2nd Edition, Tata McGraw-Hill Education 2010.
2. A.K. Jain, *Fundamentals of Digital Image Processing*, Prentice-Hall, 1989, Fourth Indian Reprint.

SEMESTER III and IV

BME 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

BME 5001 BIOMATERIALS & ARTIFICIAL ORGANS [4 0 0 4]

A Brief discussion of: metallic biomaterials, Ceramic biomaterials, Polymeric biomaterials, Composite biomaterials. Soft tissue replacements, Hard tissue replacements, Bone repair and joint implants: Dental implants, Artificial Kidney: structure and function of the kidney, kidney disease, renal failure, treatment of renal failure, Renal transplantation, Liver Support systems: Morphology of the liver, liver functions, hepatic failure, liver support systems global replacement of liver function, hybrid replacement procedures. Artificial Pancreas: Structure and function of pancreas, endocrine pancreas and insulin secretion, Diabetics, Insulin, Insulin therapy, therapeutic options in diabetics, Insulin administration systems, Insulin production systems, outlook., Artificial Blood: Modern history of blood transfusion and blood substitutes, blood components and characteristics, blood substitutes and Hem dilution, crystalloid solutions as volume expanders, Artificial skin and dermal equivalents: A vital function of skin, current treatment of massive skin loss.

References:

1. Joseph D Bronzino, "The Biomedical Engineering hand book", CRC Press Edition 2, 2000.
2. Park JoonBu, "Biomaterials Science and Engineering", Plenum Press, 1990.
3. Buddy D Ratner & Allen S. Hoftman "Biomaterials Science an introduction to Materials in Medicine" *Academic Press, 1996.*

BME 5002 CELL CULTURE TECHNIQUES AND STEM CELL BIOLOGY [4 0 0 4]

The goal of this course is to impart students with the knowledge of cell culture techniques and provide insights into stem cell biology. Students taking this course would get a detailed understanding of techniques and protocols related to animal cell cultures. Apart from cell culture techniques, students also learn the fundamental of developmental and stem cell biology. This course will be helpful for students who want to pursue a career in basic biomedical research especially in areas like tissue engineering, biomaterials, Nano biotechnology and regenerative medicine

References

1. The culture of animal cells: A manual of basic technique and specialised applications (Seventh edition). Ian Freshney Wiley, ISBN-13: 978-0879696733.
2. Essentials of Stem Cell Biology (Third Edition). Robert Lanza and Anthony Atala, Elsevier, ISBN: 978-0-12-409503-8.
3. Stem Cell Biology, Daniel R. Marshak, Richard Lavenham Gardner, David Gottlieb, Cold spring harbour laboratory press. ISBN-13: 978-0471739913.

BME 5003 DATA COMMUNICATION AND NETWORKING IN HEALTH CARE APPLICATIONS [4 0 0 4]

Data communication model, types of network and goals, Internet, Network hardware and software, design issues, ISO-OSI and TCP/IP Protocol Architecture, Data Communication Devices, communication media, data transmission, multiplexing, switching and switching techniques, Digital data communication techniques: Error detection, error correction, Data link protocols, Medium access sublayer: LAN, MAN, WAN, channel allocation, multiple access protocol, fiber optic networks, satellite networks and wireless LAN, Network layer: routing algorithms, congestion control algorithm, internetworking, internet control protocols, Internet addresses, Classes of IP addresses, TCP/IP networks, ARP and RARP, Transport layer: the transport services, transport protocols (TCP and UDP), connection management (Handshaking), Application Layer, and Network Security, healthcare applications: Health services and health information through internet / mobile (body sensor networks, Telemedicine, Tele-health/ e-health, Home healthcare/ mobile health care and mentoring).

References:

1. William Stallings, "Data and Computer communication", Prentice Hall of India, 8th Edition, 2010.
2. Tanenbaum Andrew S, "Computer Networks", Prentice Hall of India, 3rd edition, 2005.
3. Douglas E Comer, "Internetworking with TCP/IP Vol I: Principles, Protocols and Architecture", III Ed. Prentice Hall of India, 1997.
4. Behrouz. A.Forouzen, "Data Communications and Networking", 3rd Edition, Tata McGraw HILL, 2004.

BME 5004 EMBEDDED SYSTEMS [4 0 0 4]

Introduction to Embedded systems, processor and memory organization, Devices and buses for device networks, Device drivers and interrupts servicing mechanisms. Programming concepts, and embedded programming in C. Real Time Operating systems, and Serial and Parallel Buses. PIC Architecture and Instruction set, MPASM assembler and its usage, Analog-to-Digital conversion, UART. Medical Embedded systems.

References:

1. Raj Kamal, "Embedded systems Architecture, programming and Design" TaTa McGraw Hill, 4th Reprint 2008.
2. Frank Vahid and Tony Givargis, "Embedded system Design a Unified Hardware/Software Introduction" Wiley India Pvt. Ltd.
3. Tim Wilmshurst, "An Introduction to the design of Small Scale Embedded Systems" Palgrave, NewYork 2003.
4. John B. Peatman, "Design with PIC Microcontrollers", first Edition, Pearson Education.

BME 5005 EXPERIMENTAL TECHNIQUES IN BIOMEDICAL RESEARCH [4 0 0 4]

The objective of this course is to impart knowledge of various experimental techniques and methodologies related to the field of biomedical research. The course is intended for students who are interested in pursuing biomedical research associated with areas of biomaterials, drug delivery, tissue engineering, material sciences and bio nanotechnology. The course structure is divided into three major parts, of which the first and second part deals with experimental techniques employed in the characterisation of materials and biological entities. The final section of this course is meant to address questions such as how experiments are designed and to analyse experimental data critically. At the end of the course, students who completed the course would be confident in interpreting experimental data that is published in biomedical journals.

Reference:

1. Principles and Techniques of Biochemistry and Molecular Biology. Keith Wilson, John Walker, 7th edition. Cambridge University Press, ISBN 978-0-521-51635-8.
2. A Guide to Methods in the Biomedical Sciences. Ronald B. Corley, Springer.

BME 5006 MACHINE LEARNING [4 0 0 4]

Basics of machine Learning, principle and Applications in healthcare, machine Learning Foundations, Learning methods: Basic concepts in machine learning and an example. Design cycle for developing machine learning application. Perspectives and issues in machine learning. Linear models and regression models, Discriminate Functions, Single layer neural network, linear reparability, general gradient descent, perception learning algorithm, multi-layer perception: back propagation learning, Support Vector Machines (SVM), SVM for classification. Introduction to Deep learning networks. Clustering, Independent components analysis, Decision Tree learning, Reinforcement learning control, evolutionary optimization techniques, statistical machine learning, machine learning in Healthcare applications.

References:

1. Tom M. Mitchell, "Machine Learning", McGraw-Hill Education, 2013.
2. Richard o. Duda, Peter E. Hart and David G. Stork, "Pattern Classification", John Wiley & Sons Inc., 2001.

3. Ethem Alpaydin, "Introduction to Machine Learning", Prentice Hall of India, 2005.
4. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer; 2nd, 2011.
5. Saeid Sanei, and Jonathon A Chambers, "EEG Signal Processing", John Wiley and Sons, 2007.

BME 5007 PATTERN RECOGNITION [4 0 0 4]

Machine perception, Pattern recognition (PR) system, Statistical decision theory, patterns and feature extractions, Applications of Pattern Recognition, The Design Cycle, Training and learning in PR system, Pattern recognition approaches, Statistical decision making: Bayes theorem, multiple features, conditionally independent features, Decision boundaries, Unequal costs of error, Estimation of error rates, leaving one-out technique, Characteristic curves, problems, Syntactic Pattern Recognition: Syntactic pattern recognition overview, quantifying structure in pattern description and recognition, Grammar based approach and applications, Supervised Learning (Training) using parametric and non-parametric approaches, Histograms, nearest neighbor classification techniques, Unsupervised learning and clustering, Artificial Neural Networks: Introduction, Nets without and with Hidden layers, Hebbs net, Perceptron algorithm, Back propagation algorithm and Applications.

References:

1. Richchard O Duda, Peter E. Hart, David G.Strok, "Pattern Classification", Wiley edition, 2001.
2. Earl Gose, Richard, Johnson baugh and Steve Jost, "Pattern recognition and Image analysis", Prentice Hall, 2002.
3. Schalkoff Robert J, "Pattern recognition", John Wiley,1992.
4. E.S.Gelsema and L.N. Kanal, "Pattern Recognition and Artificial Intelligence", Elseveir Science, 1998

BME 5008 PERFORMANCE MODELLING OF SYSTEMS [4 0 0 4]

This course covers the topics related to input-output configuration of measuring systems, general concepts of transfer functions, instruments classification, set theory concept- Functions, relations, combinatorics, theory of counting, brief theory of bags, Graphs and algorithms-concepts of nodes and arcs, trees, Prime's algorithm, binary trees, planar graphs, Euler's theorem, Performance models, Petrinet graph, Reachability problems, S-nets and Introduction to Petrinet and S Net models.

References:

1. E. O. Doeblin, "Measurement systems: Application and Design", McGraw Hill Publishers.
2. Oliver and Cage, "Electronic measurements and instrumentation", McGraw Hill International Editions.

BME 5009 TISSUE ENGINEERING [4 0 0 4]

Introduction: Basic definition, Structural and organization of tissues: epithelial, connective tissues; Sterilization process: Introduction, different sterilization methods: physical, chemicals; applications in terms of tissue engineering, Morphogenesis, Tissue homeostasis, Cellular signaling: introduction, cellular signaling in skin, bone cartilage biology; understanding and implementing principles of cell signaling in tissue engineering; Stem cell: introduction, types, embryonic and adult stem cells, recent advances and future perspective, Cell culture, cell source, cell types, various aspects; cell-cell interaction, Molecular biology aspect, Scaffold: polymer, natural polymer for tissue engineering, degradable materials, various type of scaffold, cell –matrix interaction, micro and nanofabrication techniques in scaffold fabrication and their importance in tissue regeneration, Engineering tissues for replacing bone, cartilage

Reference Books:

1. Satya Prakash, D.S. Tim, Stem cell bioengineering and tissue engineering microenvironment, World Scientific, 2012 ISBN: 139782837882
2. Endarle, Blanchard & Bronzino, Introduction to Biomedical Engineering, Academic press, 1998
3. Frontiers in tissue engineering C.W. Patrick Jr., A. G. Mikos, L.V. Mcintire, Pergamon, Elsevier, 1998 ISBN: 008042689 1
4. B. O Palsson, Sangeeta N. Bhatia, Tissue Engineering, Edition 1, 2004 Pearson, New Jersey, USA, ISBN 0-13-041696-7
5. S. Li et al, stem cell and Tissue Engineering, World Scientific, 2011, ISBN 13 978-981-4317-05-4.

OPEN ELECTIVE

BME 5051 PHYSIOLOGICAL CONTROL SYSTEMS [3 0 0 3]

Introduction to Technological Control System, Transfer functions, Mathematical Approaches, System Stability, Feedback Concept and Stability Analysis. Introduction to Biological Control System, similarities and differences, Transfer of substances between compartments, Biological receptors, characteristics, Regulation of acid-base balance, Endocrine Control, Regulation of Extra Cellular Water and Electrolyte. Introduction to Various Process Controls like Cardiac Rate, Blood Pressure, Respiratory Rate and Blood Glucose Regulation. Modelling of Human Thermal Regulatory System, Parameters Involved, Control System Models etc. Biochemistry of Digestion. Type of Heat Loss from the Body, Model of Heat Transfer between Subsystems of Human Body like Skin, Core, etc, Respiratory control system, Modelling of O2 Uptake, Mass Balancing by Lungs, Gas Transport Mechanism of Lungs, O2 and CO2 Transport in Blood and Tissue. Introduction to Eye Tracking and Control. Cardio Vascular Control system, pupil control system, MATLAB applications in control systems.

References:

1. H. T. Milhorn, "The Applications of Control Theory to Physiological System", W.B. Saunders, 1966.
2. J. H... Milsum, Biological Control System Analysis, McGraw Hill, 1966.
3. B. C. Kuo, Automatic Control System, 9th edition, Prentice Hall, 2009.