Biomedical Engineering (BME) is a multidisciplinary field in which the principles of engineering are applied to addressing problems in physiology and medicine, providing an overall enhancement to health care.

The field involves an application of quantitative, analytical, and integrative methods from the molecular level to that of the whole organism to facilitate a better understanding of the basic physiological processes, and the development of innovative approaches for the prevention, diagnosis, and treatment of various diseases.

Students of Biomedical Engineering would be in a position to serve humanity, work with living systems, and apply advanced technology to address complex problems in health care.

The Biomedical Engineering program was started initially at the MIT in the year 1989, with a Post Graduate Program (M.Tech.) and subsequently an Under Graduate (B.E.) program in the year 1992, in the department of Electronics and Communication Engineering. The Department of Biomedical Engineering came into existence as a separate entity on August 9, 1999. Currently, the department provides a variety of modern facilities to help the students acquire an in-depth technical knowledge in the field. The faculty and students at the Department are engaged in several interesting research projects.

Academic Programmes Offered

• B.Tech. in Biomedical Engineering (since 1992)
• M. Tech. in Biomedical Engineering (since 1989)
• Ph.D

Laboratories

• Electronics Laboratory consists of several equipments and kits for performing experiments in Analog & Digital Electronics.
• Computing Laboratory consists of several computers with essential software tools, IBM PCs for Intel 8086 microprocessor assembly language programming, Intel 8051 microcontroller kits and interfacing kits such as ADC, DAC, LCD and Stepper motor.
• Biomedical Instrumentation Laboratory consists of several equipments such as: Physiograph, Defibrillator, Incubator, ECG recording system, Phonocardiograph and Sensor & Transducer kits.
• Research Laboratory is equipped with SPO2 monitoring system, DC defibrillator, Neonatal Incubator and computing facilities for research activities.
• Physiological Signal Acquisition Laboratory is equipped with the Power Lab – a 4-channel physiological signal acquisition system with a bio-stimulator to acquire physiological signals such as ECG, EEG, EMG, EOG, Respiration, Pulse, BP, and Hand grip. The lab is also equipped with a subject-bed.

Projects/Grants

• Medical Image Processing:
  - Quantitative analysis of Vertebral parameters for idiopathic scoliosis using Image Processing Techniques
  - Zebrafish image / signal processing
  - Wound-Image processing
  - Counting Mycobacteria in images of sputum smear
  - Applications of Signal Processing in Computer Assisted Tomography (CAT).
• Biomedical instrumentation: Virtual & Microcontroller based Medical Instrumentation.
• Nanotechnology: Characterization of nanocarbon.
• Physiological signal processing e.g., acquisition and processing of the ECG, respiratory waveform & the EEG.
• Cross linked biopolymer carrier matrix for transport of bioactive molecules.

Faculty List

Professor & Head
Dr Ramesh R. Galigekere, Ph.D. (Concordia University, Montreal, Canada)

Professors
Dr Gopalakrishna Prabhu K., Ph.D (IIT, Madras)
Dr Venkatesan Venkateswara Subramany., Ph.D (Edith, Cowan University, WA, Australia)

Associate Professors (Senior Scale)
Mr Jagadish Shanbhag M., M.Tech
Mr Muralidhar Bairy G., M.Tech
Dr Niranjana S., BE., Ph.D (Manipal University)

Associate Professors
Mr Lawrence D’Almeida, M.Tech
Dr Goutam Thakur, B. Pham, Ph.D (IIT, Kharagpur)

Assistant Professors (Senior Scale)
Mr Devadas Bhat, M.Tech
Ms Hilda Mayrose, M.Tech
Ms Sheeba Davis, M.Tech
<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAT 2102</td>
<td>Engineering Mathematics – III</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>BME 2101</td>
<td>Network Analysis</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 2102</td>
<td>Analog Electronics</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 2103</td>
<td>Digital Electronics</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 2104</td>
<td>Bio-Mechanics</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 2105</td>
<td>Anatomy &amp; Physiology</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 2106</td>
<td>Physiology Lab</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 2107</td>
<td>Electronics Lab</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 2111</td>
<td>Integrated Electronics Lab</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 2112</td>
<td>BME 3101</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 3102</td>
<td>Basic Clinical Sciences – III</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 3103</td>
<td>Microcontroller Based Systems</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 3104</td>
<td>Biomaterials and Prosthetics</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 3105</td>
<td>Digital Signal Processing</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 3106</td>
<td>Telemedicine</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 3107</td>
<td>Microcontroller Lab</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 3111</td>
<td>Integrated Electronics Lab</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 3121</td>
<td>BME 4001</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>HUM 4001</td>
<td>Essentials of Management</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 4101</td>
<td>Biomedical Signal Processing</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 4102</td>
<td>Advanced Image Processing</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 4103</td>
<td>Program Elective – III</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 4104</td>
<td>Program Elective – IV</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 4105</td>
<td>Program Elective – V</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 4111</td>
<td>Advanced DSP and Image Processing Lab</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 4121</td>
<td>BME 4202</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>HUM 4201</td>
<td>Engineering Economics and Financial Management</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 4202</td>
<td>Biomedical Signal Processing</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 4203</td>
<td>Advanced Image Processing</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 4204</td>
<td>Program Elective – III</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 4205</td>
<td>Program Elective – IV</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 4206</td>
<td>Program Elective – V</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>BME 4211</td>
<td>Advanced DSP and Image Processing Lab</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
</tbody>
</table>
Minor Specializations

I. Business Management
1. HUM 4011: Financial Management
2. HUM 4012: Human Resource Management
3. HUM 4013: Marketing Management
4. HUM 4014: Operations and Systems Management

Other Programme Electives
1. BME 4001: Artificial Neural Networks
2. BME 4002: Bio photonics
3. BME 4003: Data Structures and Algorithms
4. BME 4004: Drug Delivery
5. BME 4005: Health Care Management
6. BME 4006: Object Oriented Programming
7. BME 4007: Operations Research
8. BME 4008: Pattern Recognition
9. BME 4009: Physiological Control Systems
10. BME 4010: Tissue Engineering
11. BME 4011: Embedded Systems

Open Electives
1. BME 3281: Bio-medical Instrumentation
2. BME 3282: Bio-Mechanics
3. BME 3284: Rehabilitation Engineering

THIRD SEMESTER

MAT 2102: ENGINEERING MATHEMATICS - III [2 1 0 3]

References:

BME2101: NETWORK ANALYSIS [3 1 0 4]
Network topology, principles of duality & network transformation, KVL and KCL equations for DC and AC networks, network reduction using Y-transformations, coupled circuits, network theorems, series and parallel resonant circuits, transient behavior and Initial conditions in networks, switching condition and their representation, evaluation of initial and final conditions, Laplace transforms, Inverse Laplace transform and applications, one and two port networks, driving point admittance and transfer function, Open circuit impedance parameters, Short circuit admittance parameters, transmission parameters, h-parameters.

References:

BME 2102: ANALOG ELECTRONICS [3 1 0 4]
BJT characteristics: (CE CC and CB), Biasing and stabilization of Q-point, Self-bias, stability factors. BJT as an amplifier: Graphical analysis (DC and AC load line), Low frequency analysis of BJT, Composite transistors (Darlington pair, cascode connection, etc.)
JFET and MOSFET characteristics: biasing and stabilization of Q-point, Small signal analysis, CS, CD, and CG configuration. Feedback amplifier: Concept of feedback, topological classification (voltage series, voltage shunt, current series, current shunt), effect of feedback on Ri, Ro and Bandwidth of amplifier, advantages of negative feedback. Oscillators: Barkhausen criterion for sustained oscillation, Nyquist criterion for stability of amplifier, R-C phase shift oscillator, Weinbridge oscillators, RF oscillators (Colpitt's oscillator, tuned drain oscillators), Crystal

References:

BME 2103: DIGITAL ELECTRONICS [2 1 0 3]
Number systems and codes, BCD Code, Excess-3 code, Gray code error detecting codes etc. Switching algebra and simplification of Boolean expressions, realization of Logic gates, combinational logic design, minimization of Boolean functions using K Map etc., adders, DMUX, MUX decoders, Encoders, ROM circuits, etc. Introduction to sequential logic, flip-flops, asynchronous and synchronous counters, shift registers, Ring counters, etc.

References:

BME 2104: BIO-MECHANICS [4 0 0 4]

References:

BME 2105: ANATOMY & PHYSIOLOGY [4 0 0 4]

PART - A: ANATOMY

PART - B: PHYSIOLOGY
Introductory lecture pertaining basic functional concept of the human body as a whole and contribution of individual system for achieving the goal. Leverage system i.e. bone and muscle physiology in general. Nerve action potential and its ionic basis. Body temperature regulation based on thermostats - principle and its operation in different environmental temperature and its abnormalities. 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 receptor as transducers, generator potential. Motor control of skilled voluntary movements: Mechanism of abnormal oscillatory movements Electroencephalogram and electrocortcogram.

References:
BME 2111: PHYSIOLOGY LAB [0 0 3 1]

BME 2112: ELECTRONICS LAB [0 0 6 2]
To conduct the experiments related to the characteristics of Diode, Transistor, FET and other special devices. Design of power supplies: rectifier (capacitor filter), voltage doublers, quadruples, and series voltage regulator. Design of amplifiers: Transistor amplifiers with and without feedback, and FET Amplifiers. Design of oscillators: RC phase shift oscillator, Wein bridge oscillator, Hartley and Colpitt’s /Crystal oscillator (using BJT’s FET’s), UJT oscillator design. Study of TTL and CMOS gate ICs, Design of combinational circuits using IC gates. Study of MSI combinational IC chips (TTL and CMOS) such as decoder, encoder, multiplexers and demultiplexers. Sweep generator circuits, Flip-Flops: Study of flip-flop IC chips, Design of asynchronous counters and synchronous counters using flip-flop, Design of shift registers, Study of counter IC chips.

MAT 2203: ENGINEERING MATHEMATICS - IV [2 1 0 3]
Probability theory: axiomatic definition, probability space, conditional probability and independence, Bayes’ theorem; The concept of a random variable, distribution and density functions, properties, examples (specific random variables); Expected value, variance, Chebyshev’s inequality, Functions of a random variable; Random vectors, covariance, correlation coefficient, conditional distribution; Introduction to stochastic processes: definition, statistics, correlation and covariance, stationarity, ergodicity; linear systems with stochastic inputs.

BME 2201: ELEMENTS OF BIO-INSTRUMENTATION [3 0 0 3]

References:

BME 2202: INTEGRATED CIRCUIT SYSTEMS [3 1 0 4]
Operational amplifiers, characteristics, frequency response, differential amplifiers, offset voltages and currents, linear applications of OP-AMP, instrumentation amplifier, active filters, integrators and differentiators, non-linear applications of OP-AMPS, switched Capacitor filter, 555 Timer IC and its applications phase locked loops and applications, voltage to frequency converters, voltage regulators, fixed and adjustable voltage regulator, switching regulators, different type of ADC and DAC, introduction to VLSI, MOS shift registers and charge coupled devices.

References:

BME 2203: DIGITAL SYSTEM DESIGN [3 1 0 4]
Logic Families, TTL CMOS etc., ASMC charts, conventions, design examples, Asynchronous Sequential Circuits, analysis and design of asynchronous sequential circuits, Digital system design implementation options using MSI/LSI circuits, PLD’s CPLD’s, MPGAs and FPGA’s architectures and applications, implementations of digital circuits using FPGA’s, digital testing, different fault models, D algorithm, testing
sequential circuits, Design for test methods and guidelines for
combinational circuits etc.

References:
2. Michael L. Bushnell, Vishwani D. Agrawal, Essential of Electronic
testing for digital, memory and mixed VLSI signal, Kluwer Academic
3. Parag K. Lala, Fault tolerant and Fault testable hardware design, BS
publication, 1990.
4. Alexander Miczo, Russell D. Lambert, Miczo, Digital logic testing and
5. J.Bhaskar, Verilog Primer, Addison Wesley Longman Singapore Pvt
Ltd, 3rd edition

BME 2204: BASIC CLINICAL SCIENCES - I [3 0 0 3]

PART-A: CARDIOLOGY
Heart structure and function - overview, Detailed cardiovascular
physiology - blood flow (circulation), Detailed anatomy of human heart,
principles of cardiovascular measurements-blood pressure, cardiac
output, etc. Heart valves, Prosthetic heart valves evolution, detailed
structure, functions and applications, Open heart surgery and Heart lung
department, Basics of 12-lead Electrocardiography Einthoven's triangle.
ECG potentials generation and conduction, conduction system,
Applications of ECG in cardiac clinics, Normal and abnormal ECGs,
Diagnostic applications, Interpretation of ECG, Cardiac pacing. Assisted
cardiac devices-concepts and applications from biomedical engineering
perspective, Holter monitor.

PART-B: ANAESTHESIOLOGY
This course will provide an overview of basic physical principles and
their applications in anaesthesia and intensive care. It will begin with the
description of general and regional anaesthetic techniques fundamental
to the practice of anaesthesia before going on to describe the
anaesthesia machine, medical gas supply systems and intravenous drug
delivery systems. The principles of equipment used in pain therapy will
be discussed. Finally, students will learn about mechanical ventilation
with special emphasis on mechanical ventilators and nebulisers.
Humidifiers, Baby Incubators, Central oxygen supply. Principles of
operation theatre tables and lights, phototherapy, surgical diathermy.

PART-C: ENT
Anatomy and physiology of auditory system introduction, components,
outer ear, inner ear, auditory mechanism, and central auditory system.
Functional concepts of hearing central and peripheral mechanisms,
Audiogram and audiometry concepts and applications, basics of
Electrocochleogram, Hearing aids basics and future aids. Noise
pollution and cochlear implants, Anatomy of larynx, Physiology of
speech or phonation, Language disorders, Language development,
Language and brain, Pathological conditions Aphasias and Dyslexia.

References:
1. Ganong, Review of Medical Physiology [available at MIT and KMC
libraries]
2. Cyril and Neil, Samson Wright's applied physiology [available at MIT
and KMC libraries]
3. C.C. Chatterjee, Human Physiology [available at MIT and KMC
libraries]
4. M.K. Bykes and M.D. Vickers, Measurements in Anaesthesia,
Blackwell 1981.

BME 2211: INTEGRATED ELECTRONICS LAB [0 0 6 2]
Op-amp linear applications, (adders, subtractors, integrator, differentiator,
voltage to current, current to voltage converters.). Op-amp non-linear
applications. (Comparators, square wave generator, monostable
multivibrator, precision rectifier). Function generation using op-amps
(square & triangular waveform), Op-amp R-C phase shift and wein bridge
regulators (3 terminal fixed, variable and 723 or equivalent), 555 timer
applications, PLL applications, VCO IC 566, A/D & D/A converter ICs. To
conduct experiments related to digital system design.

FIFTH SEMESTER

BME 3101: BASIC CLINICAL SCIENCES - II [3 0 0 3]

PART-A: OPHTHALMOLOGY
Physiology of Eye: Structure of eye, function, Generation of signals and
transmission to brain Electrophysiology, Aqueous humor production:
Intraocular pressure fluctuations.
Equipment Used: Vision testing equipment (Computerized & Manual.),
Snellens's Chart, Keratometer, Refractometer, Colour Vision, Eye
Examination equipment: Slit lamp biomicroscope & Camera, Fundus
Camera, Ophthalmoscope-Direct & Indirect, Retinoscope, Tonometers -
contact & Noncontact, Perimeters - Listers, Bjerrums, Octopus, and
Goldmann, Ophthalmodynamometers, Ultrasound Scanners,
Synoptophore + Hesschart, Electromagnet, Lathes, Specialized
equipment used in treatment: Argon laser, Nd-YAG Laser, Contact
Lenses, Intraocular Lenses, Operating Microscope, Cryosurgical
equipment, Vitrectomy instrument.

References:
1. Miller Stephen J H, Parson Diseases Of The Eye, Churchill

PART-B: 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, Closed
methods, External fixation and Internal fixation, Biomechanics of internal
fixation and description of external fixators, Bioengineering principles of
internal fixation, Intrame: Dullary nails, Plates, and Screws.
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.

References:
3. Frankel, Lea, Febiger , Nordin, *Basic Biomechanics of the skeletal system*.

PART C: SPEECH & HEARING
Audiometers, Middle ear analyzer, Evoked potentials, OAE, Hearing aids, Cochlear implants, ALD, Hearing aid analyzer, Electro Glottography, AAC, Introduction to speech assessment, DSP, Assessment of voice and fluency, Voice and fluency therapy assessment, Artificial larynx, Spirometry, Speech synthesis, Practical demonstration.

References:

BME 3102: MICROCONTROLLER BASED SYSTEMS [3 1 0 4]

References:

BME 3103: BIO-MATERIALS AND PROSTHETICS [4 0 0 4]

References:

BME 3104: DIGITAL SIGNAL PROCESSING [3 1 0 4]

References:
BME 3105: TELEMEDICINE [3 0 0 3]
History of Telemedicine, Block diagram of telemedicine system, origin and Development of Telemedicine, Scope, Benefits and limitations of Telemedicine; Data & Signal, transmission impairments & channel capacity, Guided & Unguided transmission media, transmission of digital signal and analog signal, Multiplexing techniques: TDM & FDM, telephone system and DSL technology, cable modem & SONET, Interfacing to the medium; Switching Techniques: Circuit switching & Packet switching, IEEE 802 LAN, high speed LAN, wireless LAN, Cellular telephone systems, satellite network, Internet & internetworking: TCP/IP, multimedia networks; Data Security and Standards: Encryption, Cryptography; Ethical and legal aspects of Telemedicine; Applications of Telemedicine.

References:

BME 3111: MICROCONTROLLER LAB [0 0 6 2]
Familiarization of 8051 simulation software and 8051 instruction set, Arithmetic and logic related programs, Array handling and code conversion programs, Bit manipulation and programming using I/O ports, Timer/Counter programming, Programming using 8051 trainer kit in keyboard mode, Programming 8051 using trainer kit in serial mode and interrupt programs, Interfacing DAC, ADC, Seven segment display, keyboard, LCD and Stepper motor.

SIXTH SEMESTER

HUM 4001: ESSENTIALS OF MANAGEMENT [2 1 0 3]

References:

BME 3201 BASIC CLINICAL SCIENCES III [4 0 0 4]
PART-A: NEUROLOGY

References:
2. Erodal, Neuroanatomy. Lance and Moleod, Physiological approach to Clinical Neurology

PART-B: RADIOLOGY

PART-C: RADIOTHERAPEUTICS
Principles of radiation oncology and cancer radio therapy, LET and RBE, Radio sensitivity and Radio resistance tumors and tissues, Clinical definition of tumor radiosensitivity, Classification of tumors according to cell Radiosensitivity, Cell survival theory, Cell cyclekinetics and age response function, Cell survival curves, Oxygen effect, OER, Cell repair-subletial and potentially damage repair. Radio curability of tumors, Therapeutic ratio, Normal tissue tolerance dose, Modification of radiation response, Physical, Chemical and Biomedical modifiers, Radiation biology stages of radiation actions, Physical stage LE-RBE, Physiochemical reactions, Chemical stage. Radioactive effect of important Biological macromolecules, Radiation on cell site in cells, DNA repair process, Effects of radiation on cell cycle process, Cell death.
survival curves, Oxygen effect, Fractionation, Biological effects of Radiation, Radioactive protection, Acute Radiation syndromes, Somatic effects LD-50, Cause of radiation death - skin - blood and blood forming organs, Reproductive organs, Embryo-Late effects of Radiation, Radiation carcinogenesis, Leukemogenesis, Cataract, Genetic effects, Hazards and permissible exposures, maximum permissible occupational doses, Hazards in various branches of radiation, Protective lines of defense, Protective measures, Physical measurements and medical investigations.

References:

**BME 3202: MEDICAL EQUIPMENTS [3 0 0 3]**

References:

**BME 3203: MEDICAL IMAGE PROCESSING [4 0 0 4]**
Review of signals, systems & transforms; 2D signals & systems, 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, Compression standards. Image Enhancement: Point operations, Spatial filtering; linear filters & the median filter. 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) algorithm, 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.

References:

**BME 3211: INSTRUMENTATION & EQUIPMENT LAB [0 0 3 1]**

**BME 3212: SIGNAL PROCESSING IN MATLAB [0 0 3 1]**
Elementary Signals - unit sample, unit step, real/complex exponential, sinusoid; LSI systems: Investigation of linearity & time-invariance, Computation of impulse response, Convolution; Computing and plotting the frequency response from the transfer function/unit-sample response; Study of pole-zero plot associated with different transfer functions. DFT: Illustration of circular shift of a sequence, Circular convolution, linear convolution via circular convolution; Computation of the DFT / FFT of a signal & comparison of speed of execution for signals of different lengths; Design & Implementation of FIR and IIR filters; Random number generation; ECG: QRS detection, extraction of RRI series and calculation of heart rate; Compression of ECG using Turning Point algorithm & the Discrete cosine Transform.

References:
3. *MATLAB online help*
HUM 4002: ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT [2 1 0 3]


References:

BME 4101: BIOMEDICAL SIGNAL PROCESSING [3 0 0 3]


References:
5. A.C. Kak and M. Slaney, Principles of Computerized Tomographic

BME 4102: ADVANCED MEDICAL IMAGE PROCESSING [4 0 0 4]


References:
5. Papers / Hand-outs / Notes given in the class.

BME 4111: ADVANCED DSP & IMAGE PROCESSING LAB [0 0 3 1]

Signal Processing - Design & Implementation of FIR and IIR filters; Power spectrum estimation: Periodogram & Welch's method, AR modeling; Adaptive Signal processing algorithm. Image Processing - flipping, rotation, & scaling; Decimation & interpolation; Effects of thresholding; Bit-plane mapping; Histogram of an image; Contrast enhancement: Application of manually specified transforms, Contrast Stretching; Computation of 2D DFT, 2D FFT; Image Filtering - Spatial domain techniques: Neighbourhood averaging & Median filtering; Frequency domain techniques: High pass & low pass filtering; Edge detection; Image compression using Discrete cosine transform; Hough transform; The Radon Transform; The RT of the Shepp-Logan Phantom, image reconstruction from projections, effects of the number of projections; Convolution back projection algorithm; Geometric transformation: Translation, Scaling & Rotation; Connected component labeling.

References:
6. A.C. Kak and M. Slaney, Principles of Computerized Tomographic
EIGHTH SEMESTER

BME 4297: SEMINAR
- Each student has to present a seminar individually, on any technical topic of current interest / latest advancement / topics not covered in the syllabus.
- The topic has to approved by the Department and a report of the same has to be submitted a week before the day of the presentation.

BME 4298: INDUSTRIAL TRAINING
- Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester.
- Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the Industry.

BME 4299: PROJECT WORK / PRACTICE SCHOOL
- The project work may be carried out in the institution/industry/ research laboratory or any other competent institutions.
- The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks.
- A mid-semester evaluation of the project work shall be done after about 8 weeks.
- An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation.
- The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form.
- Student has to make a presentation on the work carried out, before the department committee as part of project evaluation.

MINOR SPECIALIZATION

I. BUSINESS MANAGEMENT

HUM 4011: FINANCIAL MANAGEMENT [2 1 0 3]
Introduction to financial management, Principle of accountancy, Sources of long term finance, Valuation of securities, Leverages, Working capital management, Capital budgeting, Cost of capital, Cash management, and Dividend decisions.

References:

HUM 4012: HUMAN RESOURCE MANAGEMENT [2 1 0 3]

References:

HUM 4013: MARKETING MANAGEMENT [2 1 0 3]

References:

HUM 4014: OPERATIONS AND SYSTEMS MANAGEMENT [2 1 0 3]
Types of production activities, Production consumption cycle, Functions of production and operations management, Importance and uses of forecasting, Product development and design: Product life cycle, Process design, Process charts, Flow diagrams and Man machine charts, Capacity planning, Aggregate planning, Scheduling, Operations strategy, Operation performance Frontier and productivity, Systems thinking, Systems engineering and its management, Systems decision process, Systems thinking, structure, classification, boundaries, visibility, System life cycle models, System dynamics and its importance in system thinking, System dynamics modeling process.
References:

OTHER PROGRAMME ELECTIVES

BME 4001: ARTIFICIAL NEURAL NETWORKS [3 0 0 3]

References:

BME 4002: BIOPHOTONICS [3 0 0 3]
Basics of Biology- Structure and types of cells, chemical building blocks, Cellular processes, Protein classification and function, Organization of cells into tissues, Types of tissue and their functions, Tumors and Cancers.
Other Technologies: Microarray Technology for genomics and proteomics, Flow cytometry, Nano-Bio-Photonics and Biomaterials for Photonics.

References:

BME 4003: DATA STRUCTURE AND ALGORITHMS [3 0 0 3]
Introduction to Data structures, arrays and strings. Introduction to algorithms: algorithm development, complexity finding, recursion. Linear data structures: Stacks, queues, circular queues and their applications. Linked lists: creation, insertion deletion operations on singly and doubly linked list. Binary trees representation and traversals such as inorder, preorder and postorder. Introduction to search trees. Sorting and Searching: insertion sort, merge sort, quicksort, heap sort, Linear search, binary search. Graphs: representation and traversals such as depth first and breadth first. Basic algorithms on graphs: Minimum spanning tree, Dijkstra's shortest path, All pairs shortest path algorithms. Static hashing.

References:

BME 4004: DRUG DELIVERY [3 0 0 3]
Overview of controlled release system, dosage form-tablet, capsule, parenteral etc. classification of drug delivery system, chemically controlled system, diffusion controlled system, controlled release mechanism- Membrane reservoir system, Matrix system, swelling controlled release system, biodegradable controlled release system; Fundamental aspects of drug delivery -diffusive transport, diffusion in heterogeneous system, passage of drug through membrane drug release kinetics from different biopolymer matrices; common routes of systemic drug administration, drug absorption, bioavailability, determinants of bioavailability- disintegration, dissolution, drug distribution, drug elimination. Characterization schemes, surface chemical analysis of polymeric drug delivery system, diffusion through skin, measuring in vitro diffusions, measuring controlled release kinetics. Polymers, hydrogels- drug carriers, transdermal and trans mucusal drug delivery system, Drug targeting approaches, biocompatibility aspects of matrices, immunity and immunological preparation-bacterial vaccines, vaccines containing living viruses, vaccines containing toxoids.
References:


BME 4005: HEALTH CARE MANAGEMENT [3 0 0 3]

Introduction: ABC of Hospital Administration, Principles of Management Human Resources: Motivation, Time Management, Leadership and Supervision, Nursing Services, Effective Communication, Conflicts, Monitoring and Control, Public Relations, Medical Social Service department, Professional Hazards, Clinical Services: Indoor Services, Outpatient Department, Casualty and Emergency Wing, Intensive Care areas, Operating room and post-operative units, Support Services: Laboratories, Blood Bank, Radiology Services, Pharmacy, Central sterile supply department, Medical Record department, Materials Management, Housekeeping and maintenance, Linen and laundry, Dietary Services, Hospital Information system and computerization, Security and safety, Finance and Budget, Costing, Medical Ethics, Law and medical profession, Hospital acquired infections, Waste disposal, Quality assurance and medical audit, Disaster Management.

References:

1. Colonel (Retd) B.M. Sakherkar, Principles of Hospital Administration and Planning, Jaypee Brothers.
3. S L Goel, R Kumar, Hospital Administration and Management, Vol 1,2,3, Deep & Deep.

BME 4006: OBJECT ORIENTED PROGRAMMING [3 0 0 3]

Fundamental concepts of programming language, Object Oriented Programming paradigm. Characteristics of OOPs, C++ Programming basics: Constants, Variables, Data-types, Expressions & Operators, Control flow: Decision making and looping and functions, Classes and Objects: Class specification, Accessing Class Members, Constructors and Destructors, Overloaded Constructors, Operator Overloading and type conversion, Inheritance: Derived class and base class, class hierarchies, Levels of Inheritance, and Multiple Inheritance, Polymorphism, and Virtual Functions, Pure function, Friend function, Friend classes, Files and streams, Exception Handling, Text mode graphic functions, Graphics mode Graphics functions, Object oriented system development.

References:


BME 4007: OPERATIONS RESEARCH [3 0 0 3]

Introduction: Definition, phases & applications of Operations Research. Formulation of L. P. P. for different applications. Assumptions in L. P. P. Graphical solution; simplex algorithm; Degeneracy, No feasible, unbounded problem, multiple optimal solutions. Concept of dual Sensitivity analysis with respect to Objective function coefficients and R.H.S values. Solution algorithm for transportation problems using North-West corner, Least cost, Vogel's Approximation method, Modified Distribution & Stepping stone methods. Solution algorithm for Assignment problems, applications, travelling salesman problem. Game theory Introduction: Saddle point; Dominance; Two people zero sum games; solution methods for 2×2 games 2×n games m×2 games, approximate method; formulation as a L. P. P. Queuing Theory introduction; Poison arrival and exponential service times system characteristics; Problems on the following modes. a) (M/M/1) : (∞/F1F1)  b) (M/M/C) : (∞/F1FO) Simulation: Introduction; Steps in simulation, application and limitations; Monte-Carlo Technique problems involving waiting line situations and selection of crew numbers. Networks: CPM & PERT Introduction; Calculation of event times, Activity times, Total Float, Free float independent float; Project Crashing.

References:

2. Vohra, Quantitative Techniques in Management, TMH

BME 4008: PATTERN RECOGNITION [3 0 0 3]

Pattern recognition system, Applications, Feature, Feature space, Class, Feature vector, Classifier, Classification and approaches, and Design cycle, Probability theory basics, Statistical decision making; Bayes theorem, Multiple features, conditionally independent features, Decision boundaries, unequal costs of error, Estimation of error rates, the leaving one-out technique, characteristic curves, and Estimating the composition of populations, Clustering: Hierarchical clustering, Agglomerative clustering algorithm, Single, Average and Complete linkage algorithms, Partitional clustering, K means, and Ward's algorithm, Artificial Neural Networks: Introduction, nets without hidden layers, Nets with hidden layers, the back propagation algorithm, Hopfield nets, Special networks, Applications: PR approach for biological signals (eg: ECG,EEG, etc). Blood sample image analysis, biometric systems, DNA analysis and other case studies.

References:


BME 4009: PHYSIOLOGICAL CONTROL SYSTEMS [3 0 0 3]

Introduction to feedback control systems, transfer functions, Block diagrams and simplification, Signal flow graphs, mechanical modeling,
time domain analysis, Routh-Hurwitz criteria, Root Locus Techniques, Bode plots, Introduction to physiological control system, different regulations in the body, physiological system differential equations, modeling the body as compartments, Urea distribution model, the human thermal systems, heat production and heat loss, Human eye tracking, pupil control system, Respiratory system, Cardiovascular system.

References:

**BME 4010: TISSUE ENGINEERING [3 0 0 3]**
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, generation of tissue in the embryo: introduction, cardiac cell development, blood vessels development, skin tissue development; future development. Tissue homeostasis: introduction, mechanism; tissue with no potential of regeneration, high potential of generation; consequence of regeneration in tissue engineering perspective, 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, future perspective. Cell culture, cell types, various aspects; cell-cell interaction, Molecular biology aspect, growth factors, receptors, growth factor release, Scaffold: engineering biomaterials for tissue engineering, degradable materials, various type of scaffold, cell matrix interaction, Engineering tissues for replacing bone, skin, cartilage, tendons, ligaments, liver.

References:

**BME 4011: EMBEDDED SYSTEMS [3 0 0 3]**
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.

References:
2. Frank Vahid and Tony Givargis, *Embedded system Design a Unified Hardware/Software Introduction*, Wiley India Pvt. Ltd.


**OPEN ELECTIVES**

**BME 3281: BIOMEDICAL INSTRUMENTATION [3 0 0 3]**

References:

**BME 3282: BIO-MECHANICS [3 0 0 3]**

References:
BME 3283: REHABILITATION ENGINEERING [3 0 0 3]

References: