BME 502 MEDICAL IMAGE PROCESSING [4-0-0-4]

Digital Image Fundamentals: Digital image representation, Elements of digital image processing system, Elements of visual perception, Image model, Imaging Geometry, Nature of Biomedical images, Objectives of biomedical image analysis, Difficulties in biomedical image acquisition and analysis.

Image Transforms: The discrete Fourier transform, Properties of two dimensional Fourier transforms, Separable image transforms, Sine and cosine transforms, the Hadamard transforms, Hough transforms, Biomedical applications.

Image Enhancement: Image enhancement by Histogram modification techniques, Image smoothing, Image sharpening, Pseudo-color image processing, Homomorphic filtering for enhancement, Adaptive contrast enhancement, Biomedical applications.

Image Restoration: Degradation model, Linear space invariant restoration filters, Blind deblurring, Homomorphic deconvolution, Biomedical applications.

Image Segmentation: Detection of discontinuities, Edge linking and boundary detection, Thresholding, Region-oriented segmentation, Use of motion in segmentation, Biomedical applications.

Image Reconstruction: Image reconstruction from projections, Radon transform, Methods for generating projection data, Transmission tomography, Reflection tomography, Emission tomography, Magnetic resonance imaging, Fourier slice theorem, Back-projection theorem.

Image Coding and Compression: Consideration based on Information theory, Lossy verses lossless compression, Distortion measures and fidelity criteria, Fundamental concepts of coding, Image coding and compression standards, Biomedical applications.

References:

1. R C Gonzalez, Wintz Paul, "*Digital Image Processing*", Addision Wesley, Edition 2, 1987.
2. A K Jain, "*Fundamental of Digital Image Processing*", Prentice Hall, 2002.
3. Rangaraj M. Rangayyan, "Biomedical Image Analysis", CRC Press, 2000.
4. Kline Jacob, "*Handbook of Biomedical Engineering*", Academic press, 1988.
5. Peter F Sharp, Philip P, Dendy Co., Ian keyees, "*Radio Nuclide Imaging*", Academic Press.
6. Sid-Ahmed Maher A, "*Image Processing Theory, Algorithms and Architecture*", McGraw Hill, 1994.

BME 504 ALLIED HEALTH SCIENCES [4-0-0-4]

PART-A PHYSIOTHERAPY

Physiology of pain and pain modulation, Pain reliving modalities-I: Role of TENS, Interferential current therapy, Pain reliving modalities-II: Superficial Heating modalities, Short wave diathermy, Ultra sound, Laser, Electrical stimulation of nerves and Muscle: type of current, wave forms, surging, Accommodation, Uses and indications, Functional electrical stimulation, EMG, nerve conduction studies, Biofeed back and other diagnostic currents, Gait and gait analysis systems.Physiology of balance, analysis of balance, instrumentation – forceplateforms, Fittnes, Cardiac and pulmonary rehabilitation- analysis and training instrumentation including Ergometer, Treadmill
Evaluation methods: Concept of MMT, Dynamometer, Isokinetics, Esthisiometer, Goniometer, Types of muscle contraction, classification of movements, Instrumentation for different type of exercise: CPM, Hydrotherapy, Suspension.
Introduction to Joint biomechanics with example of Knee and Hip joint
Orthotics and prosthesis, Practical Demonstartion

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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.

BME 512 Signal & Image Processing Lab [0-0-6-2]

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. 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: Neighbourhood 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.

BME 514 SEMINAR [0-0-3-1]

Student has to present a seminar related to the topics of Biomedical Engineering by looking into the IEEE papers and reputed Medical Journals. Also a report has to be submitted during the time of presentation.

BME 520 BIOMATERIALS AND 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, therapecific 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 Hemodilution, crystalloid solutions as volume expanders, **Artificial skin and dermal equivalents:** A vital function of skin, current treatment of massive skin loss.

Reference Books:

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.
4. L.L.Hench & E.C. Ethridge *"Biomaterials an interfacial approach*", Academic Press, New York, 1982.

BME 522 NEURAL NETWORKS [4-0-0-4]

Basics of Artificial Neural Networks: Introduction**,** Pattern and data, methods for pattern recognition tasks, Artificial neural networks: Terminology, Models of neurons, Topology. **Activation and synaptic dynamics**: Activation dynamic models, synaptic dynamic models, learning methods. **Functional units of ANN for pattern recognition tasks**: Pattern recognition problems, basic functional units, **Feedforward neural networks**: Analysis of pattern association networks, analysis of pattern classification networks, **Feedback neural networks**: Analysis of linear associative, FF Networks. **Competitive learning neural networks**: Components of competitive learning network, analysis of pattern clustering network, **Biomedical applications of ANN**: Modeling and diagnosing the cardiovascular system, Pattern recognizing of pathology images, ultrasound and magnetic resonance medical images textures analysis using ANN.

References:

1. B Yegnanarayana, "*Artificial Neural Networks*", Prentice Hall, 2001.
2. D L Hudson and M E Cohen, "*Neural Networks and Artificial Intelligence for Biomedical Engineering*", Prentice Hall, 2001.

BME 524 BioMEMS [4-0-0-4]

Introduction: Evolution of MEMS, Electronic materials and their deposition, Pattern transfer, Pattern transfer with etching techniques Pattern transfer with other physical and chemical techniques. MEMS Materials and their preparation: Metals, Semiconductors, Ceramics, Polymeric Organic materials. Standard microelectronic technologies: Wafer preparation, Monolithic processing and Mounting, Hybrid and MCM technologies. Bulk micromachining, Surface micromachining, Other micromachining techniques Microstereolithography for MEMS. Packaging techniques, Microscaling considerations, Applications in biomedical industry, Microsensors, Smart Sensors, RF applications, Future developments.

References:

1. Microsensors MEMS & Smart Devices Julian W.Gardner,Vijay K. Varadan,Osama O.Awadelkarim Wiley isbn : 0-471-86109
2. RF MEMS and their applications Vijay K Varadan K.J.vinoy & K.A.Jose ISBN 0-470-84308-X Wiley
3.MciroChip Fabrication Peter Van Zant
4. VLSI Fabrication Prinicples S.K.Gandhi, Wiley ISBN: 9814-12-694-2
Handbook for MEMS

BME 526 BIOPHYSICS [4-0-0-4]

Laws of physics and chemistry: Introduction, Quantum Mechanics, Electronic structure of atoms, Molecular Interactions, Stereochemistry and chirality, Thermodynamics, Radioactivity, Physics of fluid flow. Physics of Biomolecules: Molecular forces, Structural organization of proteins, Structural organization of nucleic acids, Thermodynamics and Biosystems: Equilibrium Thermodynamics, Near equilibrium Thermodynamics, Gibbs free energy, Bioenergetics: Bioenergetics and ATP molecules, the redox reactions, Cellular respiration, Chemiosomotic theory, Photosynthesis, Muscle contraction.

Physio-Chemical techniques to study Biomolecules: Hydration of Macromolecules, Role of friction, diffusion, Sedimentation, the ultracentrifuge, Viscosity, Rotational diffusion, Light scattering, Small angle scattering.

Spectroscopy: Ultraviolet / Visible spectroscopy, Visible spectroscopy instrumentation, Infrared spectroscopy, Raman Spectroscopy, Fluorescence Spectroscopy. Microscopy: Light Microscopy, Electron Microscopy, Electron Spectroscopy Technique: NMR spectroscopy, Mass Spectroscopy, Molecular Modelling: Generating the model, Optimizing the model.

REFERENCES:

1. Biophysics, Vasantha pattabhi and N.Gautham.
2. Elementary Biophysics, an Introduction, P.K.Srivastava.
3. Handbook of Analytical Instruments, R.S.Khandpur.
4. Spectroscopy-Gurdeep.R Chatwal and Sham K.Anand.

BME 528 PATTERN RECOGNITION [4-0-0-4]

Machine perception, Pattern recognition (PR) system, Statistical decision theory, Patterns and Feature extraction, 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, Hebs 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 .
5. Monique Pavel, *"Fundamental of Pattern Recognition*" ,Marcel Dekker Inc.,1993.
6. S N Sivanandam, S Sumathi and S N Deepa, "*Introduction to Neural Networks using MATLAB 6.0*" ,TATA McGRAW HILL, 2006

BME 530 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 532 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, **Physical layer**: Design issues, data rate of a channel (Nyquist and Shannon's formulae), communication media, data transmission, multiplexing, switching, and switching techniques, **Digital data communication techniques**: Error detection, error correction, **Data link protocols**: Flow control, Error control and protocol performance, **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, "I*nternetworking 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.
5. Sunil Kere et.al , "*Communication Networks Principles and Practice*", Tata McGraw HILL, 2004.
6. Krzysztof Zielinski, Mariusz Duplaga, David Ingram, "*Information Technology Solutions for Healthcare*", Springer / Health Informatics Series, 2010.

BME 540 (OPEN ELECTIVE) 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 O_2 Uptake, Mass Balancing by Lungs, Gas Transport Mechanism of Lungs, O_2 and CO_2 Transport in Blood and Tissue. Introduction to Eye Tracking and Control. Cardio Vascular Control system, pupil control system, MATLAB applications in control systems.

Reference Books:

1. Milhorn, *"The Applications of Control Theory to Physiological System"* J.H.Milsum, *"Biological Control System Analysis"*.
2. B.C.Kuo, *"Automatic Control System"*.
3. D.O.Cooney, *"Biological Engineering Principles"*.
4. Matlab, *"Users Manual "*