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- DIAMOND JUBILEE YEAR :: 1963 - 2023**


**DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION**
**Ph.D. Course Work syllabus**
**(Subject Domain)**
**2022-23**

Course Code	Course Title	Teaching Hours
EID01	<b>MEDICAL IMAGE PROCESSING AND ANALYSIS</b>	52 Hrs
<b>COURSE ASSESSMENT METHOD:</b>		
Semester End Exam [100 Marks, 3 Hours]		
Unit No.	Course Content	No. of Hours
1.	<b>Medical Imaging Modalities - Ionization techniques</b> <b>X-Rays:</b> X-Ray Generation and Generators, Image intensifiers, X-Ray detectors, Conventional X-Ray radiography, Digital radiography, Fluoroscopy, Angiography. <b>Computed Tomography:</b> Computed tomography working principle, Projection function, Reconstruction algorithms- Back Projection. <b>Radionuclide Imaging:</b> Interaction of nuclear particles and matter, Nuclear sources, Radionuclide generators, Nuclear radiation detectors, Rectilinear scanner, Gamma camera, SPECT principle, PET principle.	12
2.	<b>Medical Imaging Modalities – Non ionization techniques</b> <b>Ultrasound Imaging:</b> Ultrasonic transducers, Arrays, A mode, B mode, M mode scanners, Tissue characterization. <b>Magnetic Resonance Imaging:</b> Angular momentum, Magnetic dipole moment, Magnetization, Larmor frequency, Rotating frame of reference, Free induction decay, Relaxation times, Pulse sequences, Block Diagram of a magnetic resonance imager, Slice selection, Frequency encoding, Phase encoding, Spin-Echo imaging, Gradient-Echo imaging.	10
3.	<b>Artifact Removal and Image Enhancement</b> Characterization of Artifacts, Synchronized or Multiframe Averaging,	10



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	Optimal Filtering, Adaptive Filters, Comparative Analysis of Filters for Noise Removal, Noise Reduction in Nuclear Medicine Imaging. <b>Image Enhancement:</b> Homomorphic Filtering for Enhancement, Adaptive Contrast Enhancement, Objective Assessment of Contrast Enhancement.	
4.	<b>Detection of Regions of Interest</b> Thresholding and Binarization, Segmentation and Region Growing, Fuzzy-set-based Region Growing, Detection of objects of known Geometry, Methods for the Improvement of Contour or Region Estimates.	10
5.	<b>Analysis of Texture</b> Texture in Biomedical Images, Statistical Analysis of Texture, Laws' Measures of Texture Energy, Fractal Analysis, Segmentation and Structural Analysis of Texture, Systematic evaluation and validation.	10
<b>TEXT BOOKS / REFERENCES:</b>		
<b>TEXT BOOKS:</b>		
<ol style="list-style-type: none"> <li>1. <b>Principles of Medical Imaging</b>, Kirk shung, AcademicPress.</li> <li>2. <b>Biomedical Image Analysis</b>, Rangaraj M Rangayyan, CRCPress</li> </ol>		
<b>REFERENCE BOOKS:</b>		
<ol style="list-style-type: none"> <li>1. <b>Handbook of Biomedical Instrumentation</b>, Khandpur, Tata McGraw-Hill Publishing Company Ltd., Second edition, 2003.</li> <li>2. <b>Digital Image Processing</b>, Rafael C. Gonzalez &amp; Richard E. Woods, Second Edition, Pearson Education Inc.</li> </ol>		
<b>ADDITIONAL LEARNING SOURCES:</b>		
<ol style="list-style-type: none"> <li>1. <a href="https://nptel.ac.in/courses/108/105/108105091/">https://nptel.ac.in/courses/108/105/108105091/</a></li> </ol>		



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Course Code	Course Title	Teaching Hours
EID04	REHABILITATION ENGINEERING	52 Hrs
<b>COURSE ASSESSMENT METHOD:</b>		
Semester End Exam [100 Marks, 3 Hours]		
Unit No.	Course Content	No. of Hours
1.	<b>Introduction:</b> Assistive technology, universal design, seating and common pathologies, seating systems, biomechanics applications to joint structure and function, Human Joint design; Joint Function and changes in disease Postures; Static and Dynamic Postures; Analysis of Standing, Sitting and Lying Postures. the vertebral column, general structure and function, intervertebral disk, shoulder joint.	10
2.	<b>Functional Electrical Stimulation (FES):</b> clinical considerations of FES, electrodes, clinical applications, foot drop and wrist drop, spinal cord stimulation, deep brain stimulation. <b>Wheel chair design:</b> manual wheelchairs, electric power wheelchairs, power-assisted wheelchairs. wheelchair Standards.	10
3.	<b>Hearing Impairment :</b> Types of Hearing Impairment, Hearing Assistance Technology Solutions Medical or Surgical Approaches to Restoring Function Visual Substitutions to Auditory Activities Vocational, Daily Living, and Communication Aids.	10
4.	<b>Prosthetic Devices:</b> Components of the Upper Limb Prosthesis, Cosmetic Prostheses, Components of the Lower Limb Prosthesis, Hip and Pelvic Components, Knee Joints, Ankles and Feet Orthotic Devices in Rehabilitation Engineering, <b>Gait:</b> Gait cycle and joint motion; Ground reaction forces; Trunk and upper extremity motion; internal and external forces, moments and conventions; Gait measurements and analysis.	12
5.	<b>Aids for Blind or Visually impaired:</b> Dimensions of Visual Impairment and Their Impact on Task Performance, General-Purpose Assistive Technology Solutions Cortical Implants Retinal Implants Optic Nerve Stimulation Head-Mounted Displays and Image Enhancement for Low Vision. Blind Mobility Aids Audible Pedestrian Signals Technology for	10



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	Reading, Writing, and Graphics Access Computer and Internet Access, Visually Impaired Access to Telephones and Cell Phones.	
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### **TEXT BOOKS / REFERENCES:**

#### **TEXT BOOKS:**

1. Rory A Cooper, Hisaichi Ohnabe, Douglas Hubson, An Introduction to Rehabilitation Engineering, Francis & Taylor, 2007

#### **REFERENCE BOOKS:**

1. Pamela K. Levangie and Cynthia C. Norkin, Joint Structure and Function, A Comprehensive Analysis, JAYPEE Publications, Fourth Edition, 2006.
2. Dr. S. Sunder, Rehabilitation Medicine, 2nd Edition, Jaypee Medical Publications, 2004



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Course Code	Course Title	Teaching Hours
EID03	SPEECH PROCESSING	52 Hrs
<b>COURSE ASSESSMENT METHOD:</b>		
Semester End Exam [100 Marks, 3 Hours]		
Unit No.	Course Content	No. of Hours
1.	<p><b>Fundamentals of Speech signal:</b> Speech Production mechanism, Acoustic phonetic, prosody features, models for speech production and Digital models for Speech production.</p> <p><b>Fundamentals of DSP:</b> Discrete time signals, discrete time systems, Fast Fourier transforms, Digital filters, Decimation and interpolation process.</p>	10
2.	<p><b>Time Domain analysis:</b> Short time speech analysis, Short time Energy average magnitude and average zero crossing rate, Speech vs. silence discrimination using energy and zero crossing, , Short time autocorrelation function, Short time average magnitude difference function, Pitch period estimation using autocorrelation function, DSP based pitch period estimation for speech signals, Pitch period estimation using parallel processing approach.</p> <p><b>Spectral and Homomorphic speech processing:</b> Pitch period estimation and formant estimation in spectral domain, short time Fourier analysis of speech, magnitude of short time Fourier transforms, Filter bank summation method of short time Analysis and Synthesis, Spectrogram, Homomorphic speech processing, Cepstrum and its application, auditory system as a filter bank, Mel frequency cepstrum.</p>	10
3.	<p><b>Linear predictive analysis:</b> linear predictive analysis, Solution of LPC equations using autocorrelation method and covariance method. Applications of LPC parameters.</p> <p><b>Speech Coding:</b> Digital representation of speech signals, Uniform quantizer, logarithmic quantization, companded quantization, adaptive quantization, differential quantization, Waveform coding of speech: pulse code modulation, adaptive PCM, differential pulse code modulation, adaptive differential PCM, delta modulation, adaptive delta modulation,</p>	10



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	Coding in frequency domain: sub band coders, adaptive transform coding.	
4.	<p><b>Speech Synthesis:</b> Principles of Speech synthesis, Synthesis based on waveform coding, by rule and speech production mechanism, Synthesis based on analysis synthesis method, Synthesis based on speech production mechanism, text to speech system.</p> <p><b>Speech Enhancement:</b> Principles of speech enhancement , Evaluation of speech intelligibility, LMS and RLS algorithm.</p>	10
5.	<p><b>Speech and Speaker Recognition:</b> Principles of Speech recognition, Speech period detection, Spectral distance measures, Structure of word recognition systems, Techniques for speech recognition, Speech recognition based on pattern recognition approach, using neural network, and Speaker recognition: Text dependent, Text independent and text prompted methods.</p> <p><b>Auditory signal processing:</b> Anatomy and functioning of the ear, Types of hearing impairments, analog versus Digital hearing aid, DSP &amp; ASIC based hearing aids, Cochlear implants.</p>	12
<b>TEXT BOOKS / REFERENCES:</b>		
<b>TEXT BOOKS:</b>		
<ol style="list-style-type: none"> <li>1. <b>Digital Speech Processing, Synthesis and Recognition</b>, Sadoaki Furui, Second Edition, Merce Dekker 2002.</li> <li>2. <b>Speech Signal Processing</b>, V. Udayashankara, I.K. International 2022</li> </ol>		
<b>REFERENCES:</b>		
<ol style="list-style-type: none"> <li>1. <b>Digital Processing of Speech Signals</b>, L R Rabiner and R W Schafer, Pearson Education 2004.</li> <li>2. <b>Introduction to Data Compression</b>, Khalid Sayood, Third Edition, Elsevier Publications.</li> <li>3. <b>Digital Speech</b>, A M Kondo, Second Edition, Wiley Publications</li> <li>4. <b>Digital hearing aids: A tutorial review</b>, Harry levitt, Journal of Rehabilitation research, vol. 24, No.4,1987.</li> <li>5. <b>Signal processing for Cochlear Prothesis: A Tutorial review</b> , Philips C.Loizou, 1997, IEEE, Cochlear implants.</li> <li>6. <b>Designing with speech processing chips</b>, Ricardo Jimenez, Academic press, INC1991.</li> </ol>		



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Course Code	Course Title	Teaching Hours
EID05	BIOMETRICS	52 Hrs
<b>COURSE ASSESSMENT METHOD:</b>		
Semester End Exam [100 Marks, 3 Hours]		
Unit No.	Course Content	No. of Hours
1.	<b>Introduction to Biometrics</b> : Biometrics as authentication scheme, operation of a biometric system, verification versus identification, performance of a biometric system, error and accuracy in biometric systems, applications of biometrics, biometric characteristics and types, forensic biometric traits, dental, voice, signature identification.	10
2.	<b>Fingerprint recognition</b> : fingerprint sensing, acquisition devices, feature extraction, ridge orientation and frequency, segmentation, singularity detection, enhancement and binarization, minute extraction, matching approaches, palmprint features, finger print and palmprint recognition in forensics	12
3.	<b>Face recognition</b> : face recognition techniques, principal component analysis(PCA), eigenfaces, linear discriminant analysis(LDA) and fisherfaces, local face recognition and hybrid face recognition techniques, Ear as a biometric, approaches, PCA, force field transformation, acoustic ear recognition .	10
4.	<b>Iris recognition and vascular pattern recognition</b> : typical iris recognition system, image acquisition, capturing devices, iris segmentation, segmentation using the integro-differential operator, segmentation using geodesic active contours, iris normalization, coordinate transformation, image enhancement, feature extraction, recognition, encoding and matching, performance evaluation, hand vascular pattern technology, operation, acquisition, feature extraction, pattern matching.	10



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5.	<b>Gait and hand geometry:</b> Gait recognition, segmentation of walking humans, detection and extraction algorithms, shadow removal, gait cycle detection, gait analysis for feature extraction, radon transform, gait recognition, hand geometry, image capture, processing steps, performance	10
<b>TEXT BOOKS / REFERENCES:</b>		
<b>TEXT BOOKS:</b> <ol style="list-style-type: none"> <li>1. <b>Hand Book of Biometrics:</b> Anil K. Jain, Patrick Flynn, Arun A. Ross, Springer, 2008 (ISBN: 978-0-387-71040-2)</li> <li>2. <b>Signal and Image Processing for Biometrics:</b> ed. Amine Nait-Ali and Regis Fournier, Wiley 2012, (ISBN: 978-1-84821-385-2)</li> </ol>		
<b>REFERENCES:</b> <ol style="list-style-type: none"> <li>1. <b>Guide to Biometrics,</b> Ruud M. Bolle, Jonathan H. Connel, Sharath Pankanti, Nalini K Ratha, Andrew W Senior, Springer, 2009 (ISBN: 0387400893)</li> </ol>		





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Course Code	Course Title	Teaching Hours
EID02	<b>MACHINE LEARNING IN HEALTHCARE</b>	52 Hrs
<b>COURSE ASSESSMENT METHOD:</b>		
Semester End Exam [100 Marks, 3 Hours]		
Unit No.	Course Content	No. of Hours
1.	<b>Introduction, Concept Learning:</b> Introduction to machine learning in healthcare informatics, Designing Learning systems, Concept Learning, Concept Learning task, general to specific ordering, concept learning as search, Find-S algorithm, examples, Version Spaces and Candidate Elimination Algorithm, examples, Inductive bias.	<b>10</b>
2.	<b>Decision Tree Learning:</b> Introduction, representation, basic decision tree learning Algorithm, entropy measures, Information gain measures, examples, decision tree learning and hypothesis, Hypothesis Space Search.	<b>10</b>
3.	<b>Neural Networks:</b> Neural Network representation, appropriate problems for neural networks, perceptrons, perceptron training rule, gradient descent and delta rule, visualizing the hypothesis space, multilayer networks, back propagation algorithm, examples, hidden layer representations, face recognition.	12
4.	<b>Bayesian and Computational Learning:</b> Bayes Theorem, Concept Learning, Maximum Likelihood, least squared error hypotheses, Minimum Description Length Principle, Bayes Optimal Classifier, Gibbs Algorithm, Naïve Bayes Classifier, examples, Bayesian Belief Network, EM Algorithm, Nearest Neighbor Learning, Locally Weighted Regression, Radial Basis Functions, evaluating hypotheses.	10



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5.	<p><b>Applications:</b> biometric identification based on Gait, Understanding foot function during stance phase by Bayesian network based causal interference. Wavelet based Machine learning Techniques for ECG Signal Analysis. Rule learning in Health care and Health services research. Rule based computer aided decision making for Traumatic Brain injuries.</p>	10
<b>TEXT BOOKS / REFERENCES:</b>		
<p><b>TEXT BOOK:</b></p> <ol style="list-style-type: none"> <li>1. <b>Machine Learning</b>, Tom M. Mitchell, McGraw-Hill Education (INDIAN EDITION), 2013.</li> <li>2. <b>Machine Learning in Healthcare Informatics</b>, Sumeet Dua. U., Rajendra Acharya and Prerna Dua, Springer, 2014.</li> </ol> <p><b>REFERENCE BOOKS:</b></p> <ol style="list-style-type: none"> <li>1. <b>Introduction to Machine Learning</b>, Ethem Alpaydin, 2nd Ed., PHI Learning Pvt. Ltd., 2013.</li> <li>2. <b>Pattern Recognition and Machine Learning</b>, Christopher M. Bishop, Springer, 2006</li> <li>3. <b>The Elements of Statistical Learning</b>, T. Hastie, R. Tibshirani, J. H. Friedman, Springer; 1st edition, 2001.</li> </ol>		

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