**MEHRAN UNIVERSITY OF ENGINEERING AND TECHNOLOGY, JAMSHORO**

**INSTITUTE OF INFORMATION AND COMMUNICATION TECHNOLOGIES DEPARTMENT OF BIOMEDICAL ENGINEERING**

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| --- | --- | --- | --- |
| Title of Subject: | **Advanced Telemedicine Systems** | |  |
| Discipline: | ME (Biomedical Engineering) |  |  |
| Semester: | First |  |  |
| Effective: | 15BM Batch and onwards |  |  |
| Pre-Requisites: | Nil |  | Co-requisites: |
| Assessment: | Sessional Work: 10% | Mid-Semester: 30% | Written Exam: 60% |
| Marks: | Theory: 50 |  | Practical: 0 |
| Credit Hours: | 2 |  | 0 |
| Minimum Contact Hours: | 28 |  | 00 |
|  |  |  |  |

**Aims:** The students will learn about development, deployment, evaluation and outcome of advanced information systems usage in health care along with RFID in healthcare including transmission of medical information over wireless communication networks and patient data security and privacy.

**Contents**

**Fundamentals of Healthcare informatics1**

Information technology & healthcare, providing healthcare to the patients, Healthcare informatics development, Overview on telemedicine, information flooding in e-health

**Technology of telemedicine systems2**

Types of telemedicine information, tele-consultation system components, communication network & services, RFID in telemedicine

**Wireless Technology in Patient Monitoring1**

Body area networks, emergency rescue, remote recovery, at the hospital, wearable patient monitoring applications, Planning & deployment considerations, scalability to support future growth, integration with existing IT infrastructure, evaluating IT service and solution provider, quality management, evaluation of e-health & telehealth services

**Technology for safeguarding Medical Data and Privacy1**

Information security overview, cryptography, safeguarding patient medical history, anonymous data collection and processing, biometric security and identification

**Recommended Books**

1. Bernard Fong, A.C. M. Fong & C.K. Li “Telemedicine Technologies”, 2011 John Wiley & Sons Ltd,

ISBN: 978-0-470-74569-4

1. A. C Norris, “Essential of Telemedicine and Telecare, 2002 John Wiley & Sons Ltd, ISBN:0-471-53151-0



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| Approval: | Board of Studies | Res. No. 6.2 | Dated: 21-02-2014 |
|  | Advanced studies & Research board | Res. No.128.5 | Dated:29-04-2014 |
|  | Academic Council | Res. No. 83.41 | Dated:30-06-2014 |

**MEHRAN UNIVERSITY OF ENGINEERING AND TECHNOLOGY, JAMSHORO**

**INSTITUTE OF INFORMATION AND COMMUNICATION TECHNOLOGIES DEPARTMENT OF BIOMEDICAL ENGINEERING**

|  |  |  |  |
| --- | --- | --- | --- |
| Title of Subject: | **Medical Instrumentation** |  |  |
| Discipline: | ME (Biomedical Engineering) |  |  |
| Semester: | First |  |  |
| Effective: | 15BM Batch and onwards |  |  |
| Pre-Requisites: | Nil |  | Co-requisites: |
| Assessment: | Sessional Work: 10% | Mid-Semester: 30% | Written Exam: 60% |
| Marks: | Theory: 50 |  | Practical: 0 |
| Credit Hours: | 2 |  | 0 |
| Minimum Contact Hours: | 28 |  | 00 |
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**Aims:** This course aims to make the students familiar with the design and development of instrumentation for clinical measurement and biomedical research. The subject introduces the theory and practice of common sensor systems used in clinical medicine.

**Contents**

**Basic concepts and principles of measurement1**

Principles of signal acquisition, Instrument types and performance characteristics, errors in the measurement, calibration, noise and signal processing, variable conversion elements, Display, recording and presentation of data, measurement reliability and safety systems

**Sensor Technologies1**

Resistive, Capacitive, Inductive sensors, optical sensors, ultrasonic sensors, piezoelectric, piezoresistive, magnetic sensors, Hall-effect sensors, nuclear sensors, microsensors

**Transducers1,2**

Displacement and Proximity, Temperature, Pressure, Flow, Level, Mass, Force and Torque, Translational and Rotational Motion,

**Physiological Transducers2,3**

Origin of biopotentials, Biopotential electrodes, Physiological sensors and transducers

**Biomedical Instrumentation System4,5**

Components of medical instrumentation systems, General design criteria & process of instruments, Commercial medical instrumentation development process, Electrical safety of equipment

**Recommended Books**

1. Measurement and Instrumentation Principles, 3rd Edition, 2001, Alan S Morris, ISBN 0-7506-5081-8
2. Biomedical Instrumentation & Measures, Cromwell, ISBN: 9780130764485
3. Bioinstrumentation, John G. Webster (Editor), 2007, ISBN: 9788126513697
4. Medical Instrumentation: Application and Design, John G. Webster (Editor), 2009, ISBN: 9780471676003
5. Introduction to Biomedical Equipment Technology, Joseph J. Carr, 2001, ISBN: 9788177588835



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**MEHRAN UNIVERSITY OF ENGINEERING AND TECHNOLOGY, JAMSHORO**

**INSTITUTE OF INFORMATION AND COMMUNICATION TECHNOLOGIES DEPARTMENT OF BIOMEDICAL ENGINEERING**

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| --- | --- | --- | --- |
| Title of Subject: | **Statistics in Medicine** |  |  |
| Discipline: | ME (Biomedical Engineering) |  |  |
| Semester: | First |  |  |
| Effective: | 15BM Batch and onwards |  |  |
| Pre-Requisites: | Nil |  | Co-requisites: |
| Assessment: | Sessional Work: 10% | Mid-Semester: 30% | Written Exam: 60% |
| Marks: | Theory: 50 |  | Practical: 0 |
| Credit Hours: | 2 |  | 0 |
| Minimum Contact Hours: | 28 |  | 00 |
|  |  |  |  |

**Aims:** This course is a reasonably thorough treatment of the theory of probability and statistics.The course aims to give concepts of statistics as applied in medicine.

**Contents**

**Statistics and Estimation1,2,3**

Descriptive Statistics, Introduction to Probability, Confidence interval, Discrete Probability Distributions, Continuous Probability Distributions, Central limit theorem, Conditional Probability, Joint Probability, Bayes’ theorem, Bayesian Inference, Relative Risk, Chi-Squared values, P-values, Relationship between Population and Sample, Estimation of the Mean of a Distribution, Estimation of the Variance of a Distribution, Maximum Likelihood

**Medical Statistics4,5**

Contingency matrix, pre-test probability, post-test probability, sensitivity, specificity, Expected value decision making, Receiver Operating Characteristic curve, Life expectancy, treatment threshold probability, Quality adjusted life years, Disease incidence rate, disease prevalence rate, mortality and morbidity rates, Kappa Statistics

**Regression and Correlation4**

General Concepts, Fitting Regression Lines, the Correlation Coefficient, Statistical Inference for Correlation Coefficients, Multiple Regressions

**Recommended Books**

1. Fundamentals of Biostatistics, Bernard Rosner, 7th Edition, 2010, ISBN-13: 978-0538733496
2. Biostatistics: A Foundation for Analysis in the Health Sciences, 10th Edition, Wayne W. Daniel, 2013, ISBN-13: 978-1118302798
3. Probability and Statistics for Engineers and Scientists, Ronald E. Walpole, 9th Edition, 2011, ISBN-13: 978-0321629111
4. Medical Statistics, 4th Edition, David Machin, Michael J Campbell, Stephen J Walters, ISBN: 978-0-470-02519-2
5. Medical Informatics, 2nd Edition, Edward H. Shortliffe, Leslie E. Perrault, 2001, ISBN: 0-387-98472-0



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**INSTITUTE OF INFORMATION AND COMMUNICATION TECHNOLOGIES DEPARTMENT OF BIOMEDICAL ENGINEERING**

|  |  |  |  |
| --- | --- | --- | --- |
| Title of Subject: | **Digital Signal Processing for Measurement Systems** | |  |
| Discipline: | ME (Biomedical Engineering) |  |  |
| Semester: | First |  |  |
| Effective: | 15BM-Batch and onwards |  |  |
| Pre-Requisites: | Nil |  | Co-requisites: |
| Assessment: | Sessional Work: 10% | Mid-Semester: 30% | Written Exam: 60% |
| Marks: | Theory: 100 |  | Practical: 0 |
| Credit Hours: | 3 |  | 0 |
| Minimum Contact Hours: | 42 |  | 00 |
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**Aims:** The course aims to give students the fundamentals of digital signals. It will then investigate a number of advanced signal processing tools and the mathematical concepts they are based on. Finally, the performances of DSP based measurement systems are learned.

**Contents**

**Review of Signals1,2,3**

Signals, some important signals, Continuous-time signals, Discrete-time signals, basic time operations, even signals, odd signals, signals in frequency domain, Fourier transform, Sampling of continuous-time signals, Sampling theorem, Quantization, encoding, A system, Linear Time-Invariant systems, unit pulse response, difference equation, Signal energy, Signal power, Convolution sum, Cross correlation, Auto-correlation

**Transforms of the discrete domain3**

The discrete Fourier transform, System frequency response, The Z transform, Pulse transfer function (PTF), Obtaining PTF from a difference equation

**Digital filter design3,4**

Fundamental concepts of filters, filter approximations, Ideal filters, Concepts of FIR and IIR systems, Design of FIR filters using Window method, Methods of IIR filter Design, Spectral Estimation

**Advanced Signal Processing3,4**

Basic Wiener filter theory, Adaptive Signal Processing, Least Squares Method, Recursive LSM, Multi-rate signal processing, DSP processors, Performance of DSP based measurement systems

**Recommended Books**

1. Signals and Linear Systems Analysis, Gordon E. Carlson, 2nd Edition, 1998, ISBN: 978-0471124658
2. Digital Signal Processing for Measurement Systems: Theory and Applications, Gabriele D'Antona, 2006, ISBN: 9780387249667
3. Digital Signal Processing: Principles, Algorithms, and Applications, John G. Proakis, 4th Edition, 2007, ISBN: 9788131710005
4. Digital Signal Processing: A Practical Approach, Emmanuel C. Ifeachor, 2nd Edition , 2002, ISBN: 9788131708248



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|  |  |  |  |
| --- | --- | --- | --- |
| Title of Subject: | **Ultrasonic Instrumentation and Imaging** | |  |
| Discipline: | ME (Biomedical Engineering) |  |  |
| Semester: | First |  |  |
| Effective: | 15ME-BME and onwards |  |  |
| Pre-Requisites: | Nil |  | Co-requisites: |
| Assessment: | Sessional Work: 10% | Mid-Semester: 30% | Written Exam: 60% |
| Marks: | Theory: 50 |  | Practical: 0 |
| Credit Hours: | 2 |  | 0 |
| Minimum Contact Hours: | 28 |  | 00 |
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**Aims:** This course provides the basic principles of ultrasound physics and technology, ultrasound imaging modes, transducer, imaging techniques, and ultrasound applications in medical imaging and instrumentation.

**Contents**

**Physics of ultrasound1**

Fundamentals of Ultrasound, Echoes, Wave Equation, Impedance, Power an Reflection, Scattering, Attenuation, transducers, Single-element and array transducers

**Ultrasound Fields1**

Continuous wave, Pulsed Pressure, Pulse Echo fields, Axial and Lateral Resolution, Focal Spot Size, Ultrasound nonlinearity

**Principles of ultrasound imaging and instrumentation2**

A-Mode, B-Mode, M-Mode, C-Mode, Doppler, Harmonic imaging, Elasticity imaging, Acoustic Microscope

**Applications3,4**

Ultrasound tissue characterization, Micro-bubble contrast agents, Blood flow measurement, ultrasound in drug delivery, high intensity focused ultrasound (HIFU) for therapy.

**Recommended Books**

1. Diagnostic Ultrasound Imaging: Inside Out, Thomas L. Szabo, 2nd Edition, 2013, ISBN-9780123964878
2. Biomedical Technology and Devices,: Handbook, Ed: James Moore, George Zouridakis, 2004, ISBN: 0-8493-1140-3
3. Biomedical Signal and Image Processing, KayvanNajarian, Robert Splinter, 2nd Edition, 2012, ISBN: 978-1-4398-7033-4
4. Richard S. C. Cobbold “Foundations of Biomedical Ultrasound”, 2006, ISBN: 13978-0-19-516831-0



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| --- | --- | --- | --- |
| Title of Subject: | **Medical Image Processing** |  |  |
| Discipline: |  |  |  |
| Semester: | Second |  |  |
| Effective: | 15BM Batch and onwards |  |  |
| Pre-Requisites: | Nil |  | Co-requisites: |
| Assessment: | Sessional Work: 10% | Mid-Semester: 30% | Written Exam: 60% |
| Marks: | Theory: 50 |  | Practical: 0 |
| Credit Hours: | 2 |  | 0 |
| Minimum Contact Hours: | 28 |  | 00 |
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**Aims:** This course focuses on processing of medical images, including enhancement, denoising, visualization and analysis for feature extraction and classification.

**Contents**

**Fundamental Concepts of Image Processing1**

Fundamentals of digital image processing, the gray-level histogram, histogram transformations and look-up tables

**Image Enhancement in the Spatial Domain1**

Algebraic operations, Logical (Boolean) operations, Geometric operations, Convolution-based operations

**Image Enhancement in the Frequency Domain2**

The Fourier domain, The Fourier transform, Properties of the Fourier transform, Sampling, Cross-correlation and autocorrelation, Imaging systems – point spread function and optical transfer function, Frequency domain filters, Tomographic reconstruction

**Image Restoration**

Image degradation, noise, noise-reduction filters, de-blurring, modeling image degradation, Geometric degradations, morphological image processing, mathematical morphology, morphological operators, and extension to gray-scale images

**Image Segmentation**

Introduction, thresholding, region-based methods, boundary-based methods

**Image Classification**

Object recognition and classification, connected components labeling, Features, Object recognition and classification, statistical classification, structural/syntactic classification, applications in medical image analysis

**Three-Dimensional Visualization**

Image visualization, Surface rendering, Volume rendering, Virtual reality



**Recommended Books**

1. Digital Image Processing for Medical Applications, Geoff Dougherty, © Cambridge University Press, Cambridge University Press, ISBN: 978-0-521-86085



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| --- | --- | --- | --- |
| Title of Subject: | **Mechatronics in Medicine** |  |  |
| Discipline: |  |  |  |
| Semester: | 2nd |  |  |
| Effective: | 15BM batch and onwards |  |  |
| Pre-Requisites: | Nil |  | Co-requisites: |
| Assessment: | Sessional Work: 10% | Mid-Semester: 30% | Written Exam: 60% |
| Marks: | Theory: 50 |  | Practical: 0 |
| Credit Hours: | 2 |  | 0 |
| Minimum Contact Hours: | 28 |  | 00 |



**Aims:** This subject is aimed at giving concepts in Mechatronics as a multidisciplinary field, with applications in prosthetics and rehabilitation. The subject shall cover the biomedical implants also.

**Contents**

**Mechatronic Systems1,2**

Machine Elements, Electronic Elements, Computing Elements, Sensing Elements, Actuation

Elements, Data Acquisition

**Biomechatronic Systems3**

Introduction, Sensors for Biomechatronics, Actuators for Biomechatronics, Biomechatronic Systems, Hearing Aids, Heart Aids, Respiratory Aids, Prosthetic Limbs

**Robotic Systems4**

Types of Robot, Robotic arm terminology, robotic arm configuration, basic robotic systems, Robot manipulators, Robotic manipulator kinematics, robotic arm positioning concepts, robotic arm path planning, actuators, Robot accessories, Robotic Sensors, End effectors, Robotic Grippers, Robot drives, Robot controllers

**System Models5**

Elements of mechanical systems, spring-mass damper system, an unconventional approach of modeling, arrangement of mechanical elements, Rack and Pinion arrangement, elements of an electrical system, unconventional solution to RLC circuit, application to DC servomotor , Hydraulic system modeling, modeling of actuators, modeling of control valves, thermal systems, modeling of thermal systems

**Applications6**

Medical applications of robot, surgical robots, nanorobots, Robotjet, robots for material handling, robots for disaster management, Grand Challenges for Robotics, Vision guided robotics

**Recommended Books**

1. Introduction to Mechatronics and Measurement Systems, David G. Alciatore, Michael B. Histand, 4th Edition, 2011, ISBN: 9780073380230
2. Introduction to Mechatronics AppuuKuttan, 1st Edition, 2007, ISBN: 9780195687811
3. Mechatronics: Principles and Applications, Godfrey Onwubolu, 2005, ISBN: 9780080492902
4. Mechatronics, G. Hegde, 2010, 9781449668150

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| --- | --- | --- | --- |
| Title of Subject: | **Operations Management** |  |  |
| Discipline: |  |  |  |
| Semester: | 2nd |  |  |
| Effective: | 15BM batch and onwards |  |  |
| Pre-Requisites: | Nil |  | Co-requisites: |
| Assessment: | Sessional Work: 10% | Mid-Semester: 30% | Written Exam: 60% |
| Marks: | Theory: 100 |  | Practical: 0 |
| Credit Hours: | 2 |  | 0 |
| Minimum Contact Hours: | 28 |  | 00 |
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**Aims:** This course provides an introduction to the management of operations, products, services, quality and projects.

**Contents**

**Introduction to Operations Management**

Introduction, Current issues in operations management, Introduction, Strategy, Strategic role of operations and operations, Managers, Strategy in context of manufacturing and service

**Policy**

Developing new products and Services, Innovation, Introduction to NPD, Importance of NPD, Process of NPD, Best practice in NPD, Operations Processes, Introduction, Factors affecting process design, Types of generic process, Physical layout, Trends in process design, Manufacturing, Managing Supply, Capacity, Throughput and Quality, Introduction, Understanding supply, Evolution from purchasing to supply, management, sourcing strategies

**Practice**

Introduction, Understanding capacity, Determinants of demand, Strategies for matching supply and demand, Managing throughput, Improving material, Customer and information flows, Managing operations, Flows, Inventory, Improving operations flows, Project management, Designing the project process, Project planning, Work breakdown structure and stage-gate planning

**Performance Improvement**

Quality, Historical perspective on Quality, Quality management, Quality standards and certification, Service quality, Quality awards programs, Design quality, Total quality Management, Performance measurement, Continuous improvement, Radical performance improvement, World-Class Operations, Lean Production, Importance of human resources, Quality and innovation in WCO, Reconfiguration of firms, Mergers and alliances, Ethics In WCOs, Analyzing manufacturing operations, Quantitative, Methods, Statistical approaches, Forecasting techniques, Index numbers, Operational research techniques, analyzing service operations, Service delivery, Queuing and shift scheduling, Designing and analyzing service systems, Mathematical tools and techniques for analyzing services

**Recommended Books**

1. Operations Management: Policy, Practice and Performance Improvement, Steve Brown, Kate Blackmon, Paul Cousins, Harvey Maylor, 2001, ISBN: 978-0750649957, ISBN: 0 7506 4995 X

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| --- | --- | --- | --- |
| Title of Subject: | **Radiography and Computed Tomography** | |  |
| Discipline: | ME (Biomedical Engineering) |  |  |
| Semester: | 2nd |  |  |
| Effective: | 15BM batch and onwards |  |  |
| Pre-Requisites: | Nil |  | Co-requisites: |
| Assessment: | Sessional Work: 10% | Mid-Semester: 30% | Written Exam: 60% |
| Marks: | Theory: 100 |  | Practical: 0 |
| Credit Hours: | 3 |  | 0 |
| Minimum Contact Hours: | 42 |  | 00 |



**Aims:** This subject is aimed at giving basic and advanced concepts of X-ray imaging. The subject shall cover Medical applications of X-ray imaging. The subject shall also span the techniques of image reconstruction methods in Computed Tomography and image processing for image enhancement.

**Contents**

**X-ray Radiography1,2**

Physics of X-ray and Gamma rays, Properties of X-rays and Gamma rays, X-ray Generation, Bremsstrahlung, Hard X-rays, Soft X-rays, Interaction of X-rays and Gamma rays with matter, characteristic radiation, Imaging with X-rays, Attenuation Based X-ray Imaging, X-ray Detection, Image formation physics, Modeling film characteristics, Florescence, CCD sensors, Scintillation counter, Radiation Dose, Biological effects of X-rays, KERMA, X-ray Image Quality, Imaging geometry, scattering effects.

**Computed Tomography1,2**

Attenuation tomography, Time of flight formulation of attenuation CT, Fourier reconstruction, CT image artifacts tomography, Reflection tomography, Diffraction tomography, Slice theorem, CT scanners, Scanningconfigurations,Spira

**Radiography for Medical Applications**

Volumetric measurement of tumors, bone fracture detection, Coronary obstruction visualization, mammography, pneumonia

**Image Visualization, Reconstruction and Enhancement1**

Image as 2D spatial function, Image resolution, Image Histogram, image contrast, histogram normalization, histogram equalization, Color spaces, spherical transform, enhancing a color image, image segmentation, spatial domain filtering, 2D DFT, frequency domain filtering

**Laboratory**

The laboratory exercises shall be performed on image processing using Matlab.

**Recommended Books**

1. Biomedical Signal and Image Processing, KayvanNajarian, Robert Splinter, 2nd Ed., 2012, ISBN: 978-1-4398-7033-4
2. Introductory Medical Imaging, A. A. Bharath, 2009, ISBN: 9781598296112
3. Biomedical Imaging, Karen M. Murdy, Robert Plonsey, Joseph D Bronzino, 2003, ISBN:0-8493-1810-6
4. Non-Destructive Test and Evaluation of Materials, Jaymangal Prasad, C. G. Krishnadas Nair, 2008, 978-0-07-062084-1



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| --- | --- | --- | --- |
| Title of Subject: | **Laser and Spectroscopy** |  |  |
| Discipline: | ME (Biomedical Engineering) |  |  |
| Semester: | 2nd |  |  |
| Effective: | 15BM batch and onwards |  |  |
| Pre-Requisites: | Nil |  | Co-requisites: |
| Assessment: | Sessional Work: 10% | Mid-Semester: 30% | Written Exam: 60% |
| Marks: | Theory: 50 |  | Practical: 0 |
| Credit Hours: | 2 |  | 0 |
| Minimum Contact Hours: | 28 |  | 00 |



**Aims:** This subject is aimed at giving fundamental concepts of photonics, lasers and spectroscopy. The subject shall also cover Medical applications of lasers and spectroscopy.

**Contents**

**Fundamentals of Photonics and Lasers1**

Photon Detectors, Noise in Photon Detectors, Photodiode Detectors, Lasers and Coherent Light, Optical Resonators, Gaussian Beam Optics, Stimulated Emission and Optical Gain, Optical Amplifiers, Laser Oscillation, CW Laser Characteristics, Pulsed Lasers, Optically Pumped Lasers, Electrically Pumped Lasers

**Spectroscopy2,3**

Fundamental principles of spectroscopy, prism spectrometer, grating spectrometer, interferometers, wavelength measurements, lasers as spectroscopic light sources, Ultraviolet spectroscopy, Infrared spectroscopy, Raman spectroscopy, Flame photometry, Emission spectroscopy, Fluorometry and phosphorimetry, photoacoustic spectroscopy, mass spectroscopy

**Applications of Laser and Spectroscopy4,5**

Laser instrumentation and measurement, principles used in measurement, Distance measurement, Laser spectroscopy for medical diagnosis

**Recommended Books**

1. Photonics and Lasers: An Introduction, Richard S. Quimby, 2006, ISBN: 978-0-471-71974-8
2. Spectroscopy, 12th Edition, 2007, B. K. Sharma, ISBN: 81-8283-018-4
3. Laser Spectroscopy: Basic Concepts and Instrumentation, 4th Edition, Wolfgang Demtroder, ISBN: 3-540-65225-6
4. Pavia Lampman, Kriz, Vyvyan, Introduction to Spectroscopy, 4th Edition, ISBN: 978-0-495-11478-9



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**INSTITUTE OF INFORMATION AND COMMUNICATION TECHNOLOGIES DEPARTMENT OF BIOMEDICAL ENGINEERING**

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| --- | --- | --- |
| Title of Subject: | **Simulation of Dynamic Systems** |  |
| Discipline: | ME (Biomedical Engineering) |  |
| Semester: | 3rd |  |
| Effective: | 15BM batch and onwards |  |
| Pre-Requisites: | Nil | Co-requisites: |
| Assessment: | Sessional Work: 40% | Written Exam: 60% |
| Marks: | Theory: 00 | Practical: 100 |
| Credit Hours: | 0 | 1 |
| Minimum Contact Hours: | 00 | 42 |



**Aims:** This subject is aimed at giving concepts and hands on experience of simulation of physiological and biomechanical systems for optimizing processes and products.

**Course Objectives:**

* Mathematical description of physical systems.
* Techniques of modeling and analysis of dynamic systems.
* Identification and parameterization of models from experimental data.
* Knowledge of simulation tools of dynamic systems and their use.

**Contents**

Introduction, history, models as approximations of real world events Characteristics and discriptors of models and simulation

categories of Models and simulation

Life-time of simulation, many facets of simulation, experimentation and experience aspect of simulation

**Discrete event simulation1,2**

Queing system model components, simulation methodology, DES examples, Hand simulation, Arena simulation, sequential simulation, Simpackqueing implementation, parallel simulation

**Modeling continuous systems1,2**

System class, M&S strategy, Modeling approach, Model examples, Simulation implementation

**Monte Carlo simulation1,2**

Sensitivity analysis, applications of Monte Carlo simulation

**System Modeling1,2**

Types of system models, Examples of modeling in biomechanics and physiology Operations Research methods

**Recommended Books**

1. Modeling and Simulation Fundamentals: Theoretical Underpinnings and Practical Domains, John A. Sokolowski, 2010, ISBN: 978-0-470-48674-0
2. Principles of Modeling and Simulation: A Multidisciplinary Approach, John A. Sokolowski, 2011, ISBN: 9781118210949



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| Approval: | Board of Studies | Res. No. 6.2 | Dated: 21-02-2014 |
|  | Advanced studies & Research board | Res. No.128.5 | Dated:29-04-2014 |
|  | Academic Council | Res. No. 83.41 | Dated:30-06-2014 |

**MEHRAN UNIVERSITY OF ENGINEERING AND TECHNOLOGY, JAMSHORO**

**INSTITUTE OF INFORMATION AND COMMUNICATION TECHNOLOGIES DEPARTMENT OF BIOMEDICAL ENGINEERING**

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| --- | --- | --- | --- |
| Title of Subject: | **Advanced Imaging Techniques** | |  |
| Discipline: | ME(Biomedical Engineering) |  |  |
| Semester: | 3rd |  |  |
| Effective: | 15ME-BME and onwards |  |  |
| Pre-Requisites: | Nil |  | Co-requisites: |
| Assessment: | Sessional Work: 10% | Mid-Semester: 30% | Written Exam: 60% |
| Marks: | Theory: 50 |  | Practical: 0 |
| Credit Hours: | 2 |  | 0 |
| Minimum Contact Hours: | 28 |  | 00 |



**Aims:** This subject is aimed at giving advanced concepts of imaging. The subject shall cover Medical applications of imaging using Thermal, PET, and MR imaging modalities. The subject shall also span Functional MR Imaging.

**Contents**

**Infrared Thermal Imaging1**

Introduction and fundamentals, Properties of IR imaging systems, Advanced methods in IR imaging, Basic concepts of heat transfer, Applications, Direct visualization of physical phenomena, IR imaging of buildings and infrastructure, Detection of gases, Microsystems, Thermal reflections, electrical applications, IR imaging in medicine, Pathophysiological-based Understanding of IR Imaging, IR imaging for breast cancer detection, New generation IR technologies

**Positron Emission Tomography2,3**

Introduction, Physical and physiological principles of PET, PET signal acquisition, PET image formation, Significance of PET, Applications of PET, Comparison of CT, MRI and PET, Single Photon Emission Computed Tomography

**Magnetic Resonance Imaging3,4**

Introduction, Nuclear magnetism, Resonance, Physical and physiological principles of MRI, Mathematical formulation, Functional MRI, Bold MRI, Applications, Comparison of MRI with other imaging modalities, Registration of MR images

**Recommended Books**

1. Infrared Thermal Imaging: Fundamentals, Research, and Applications, M. Vollmer, K. P. Mollman, 2010, ISBN: 978-3-527-40717-0
2. Basics of PET Imaging, Gopal B Saha, 2nd Edition, 2010, ISBN: 978-1-4419-0804-9
3. Biomedical Signal and Image Processing, KayvanNajarian, Robert Splinter, 2nd Edition, 2012, ISBN: 978-1-4398-7033-4
4. Biomedical Imaging, Karen M. Murdy, Robert Plonsey, Joseph D Bronzino, 2003, ISBN:0-8493-1810-6



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**INSTITUTE OF INFORMATION AND COMMUNICATION TECHNOLOGIES DEPARTMENT OF BIOMEDICAL ENGINEERING**

|  |  |  |  |
| --- | --- | --- | --- |
| Title of Subject: | **Research Methodology** |  |  |
| Discipline: | ME (Biomedical Engineering) |  |  |
| Semester: | 3rd |  |  |
| Effective: | 15ME-BME and onwards |  |  |
| Pre-Requisites: | Nil |  | Co-requisites: |
| Assessment: | Sessional Work: 10% | Mid-Semester: 30% | Written Exam: 60% |
| Marks: | Theory: 100 |  | Practical: 0 |
| Credit Hours: | 3 |  | 0 |
| Minimum Contact Hours: | 42 |  | 00 |
|  |  |  |  |

**Aims:** This course provides basic concepts of research and its methodologies. Students will learn how to identify appropriate research topics, select and define a research problem and parameters, collect and analyze data, write a project report, a thesis and a research proposal.

**Objectives:** At the end of this course, the students should be able to:

* understand some basic concepts of research and its methodologies
* identify appropriate research topics
* select and define appropriate research problem and parameters
* prepare a project proposal (to undertake a project)
* organize and conduct research (advanced project) in a more appropriate manner
* write a research report and thesis
* write a research proposal (grants)
* use software tools for data analysis
* manage literature review and bibliography using software tools

**Contents**

**Introduction**

Research and its characteristics, types of research, research process

**Research problem**

Study population, subject area, considerations in selecting a research problem, defining and formulating a research problem, methodology, preparing the research design, conducting the research, examples of research at the university

**Literature review**

Knowledge base, findings, contextualizing the findings, clarity and focus of research problem, finding and managing references

**Formulation of objectives**

Characteristics of objectives, concepts, indicators and variables, identifying variables, types of measurement scales, constructing hypotheses, functions of hypotheses

**Collecting data**

Ethical issues in data collection, collecting information, seeking consent, providing incentives, seeking sensitive information, possible harm to the participants, maintaining confidentiality

**Processing and analyzing data**

Editing data, classifying data, tabulating data, metadata, qualitative data analysis, quantitative data analysis, analysis of variance, hypothesis testing, Kruskal-Wallis test, manual data analysis, computer tools for data analysis

**Report writing**

Writing a research proposal, writing a project report, writing a thesis, writing a research paper, referencing, software for referencing

**Recommended Books**

1. Research Methodology, P. Sam Daniel, 2011, ISBN: 978-81-7835-900-7
2. Practical Research Methods, Catherine Dawson, 2002, New Delhi, UBS Publishers’ Distributors
3. Research Methodology - Methods and Techniques, C. R. Kothari, 1985, New Delhi, Wiley Eastern Limited, ISBN:
4. Research Methodology-A Step-by-Step Guide for beginners, 2nd Ed., Ranjit Kumar, 2005, Singapore, Pearson Education, ISBN:
5. Fundamentals of Research Methodology and Statistics, Yogesh Kumar Singh, 2006, ISBN : 978-81-224-2418-8



**Laboratory Exercises**

SPSS/PASW/ANOVA or similar data analysis tool, EndNote, JabRef, Reference Manager, online tools such as bibMe ([http://www.bibme.org](http://www.bibme.org/)/) and EasyBib ([http://www.easybib.com](http://www.easybib.com/)/), search tools, LATEX



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