LIST OF COURSES

S.No	Course Code	Name of the Course	Credits
1.	17BM2001	Health and Hospital Management	3:0:0
2.	17BM2002	Biomedical Sensors and Transducers	3:0:0
3.	17BM2003	Biomedical Sensors and Transducers Laboratory	0:0:2
4.	17BM2004	Medical Electronics	3:0:0
5.	17BM2005	Bio Signal Conditioning Circuits	3:0:0
6.	17BM2006	Bio Signal Conditioning Circuits Laboratory	0:0:2
7.	17BM2007	Biocontrol systems	3:0:0
8.	17BM2008	Medical Diagnostic Equipment	3:0:0
9.	17BM2009	Biomechanics Prosthesis and Orthosis	3:0:0
10.	17BM2010	Bio Signal Processing Laboratory	0:0:2
11.	17BM2011	Medical Therapeutic Equipment	3:0:0
12.	17BM2012	Biomedical Instrumentation Laboratory	0:0:2
13.	17BM2013	Modelling of Physiological systems	3:0:0
14.	17BM2014	Medical Imaging Techniques	3:0:0
15.	17BM2015	Digital Image Processing for Medical Applications	3:0:0
16.	17BM2016	Embedded Biomedical Instrumentation Systems	3:0:0
17.	17BM2017	Embedded Biomedical Instrumentation Systems Laboratory	0:0:2
18.	17BM2018	Bio Virtual Instrumentation Laboratory	0:0:2
19.	17BM2019	Medical Image Processing Laboratory	0:0:2
20.	17BM2020	Surgical Assist Systems	0:0:1
21.	17BM2021	Sensory and Motor Rehabilitation	3:0:0
22.	17BM2022	Medical Equipment, Maintenance and Troubleshooting	3:0:0
23.	17BM2023	Biomedical Optics	3:0:0
24.	17BM2024	Biometric systems	3:0:0
25.	17BM2025	Radiation and Nuclear Medicine	3:0:0
26.	17BM2026	Patient and Device Safety	3:0:0
27.	17BM2027	ICU and Operation Theatre Equipment	3:0:0
28.	17BM2028	Graphical System Design for Biomedical Engineers	3:0:0
29.	17BM2029	Wearable Systems and Digital Health Care	3:0:0
30.	17BM2030	Bio-MEMS Technology	3:0:0
31.	17BM2031	Soft Computing Techniques	3:0:0
32.	17BM3001	Advanced Medical Instrumentation	3:0:0
33.	17BM3002	Medial Image Computing	3:0:0
34.	17BM3003	Soft Computing Techniques for Biomedical Engineers	3:0:0
35.	17BM3004	Medical Sensors and MEMS Technology	3:0:0
36.	17BM3005	Modeling and Identification of Physiological Systems	3:0:0
37.	17BM3006	Rehabilitation Engineering	3:0:0
38.	17BM3007	Medical Ethics	3:0:0
39.	17BM3008	Embedded system and IoT in health care	3:0:0
40.	17BM3009	Diagnostic and Therapeutic Laboratory	0:0:2
41.	17BM3010	Medical sensors, Interfacing & MEMS Laboratory	0:0:2
42.	17BM3011	Embedded System and IoT Laboratory	0:0:2
43.	17BM3012	Ambulatory Services	3:0:0
44.	17BM3013	Telehealth Technology	3:0:0
45.	17BM3014	Hospital and Equipment Management	3:0:0
46.	17BM3015	Robotics in Surgery	3:0:0
47.	17BM3016	Speech Signal Processing	3:0:0
48.	17BM3017	Hospital Automation	3:0:0
49.	17BM3018	Human Assist Devices	3:0:0

50.	17BM3019	Human Computer Interfaces	3:0:0
51.	17BM3020	Ergonomic in Hospitals	3:0:0
52.	17BM3021	Finite Element Modeling in Biomedical Engineering	3:0:0

17BM2001 HEALTH AND HOSPITAL MANAGEMENT

Credits: 3:0:0

Course Objectives:

- To understand the need and significance of Clinical Engineering and Health Policies.
- To familiarize the training strategies, quality management policies and information technology used in health care.
- To know the needs of managerial training to hospital staffs

Course Outcomes:

- Identify the role of the manager in healthcare and how organisations and people work within the healthcare system.
- Evaluate and use measurement tools for quality and safety.
- Describe how high quality services can best be designed, configured and delivered.
- Demonstrate a strategic leadership role as an advocate for improved healthcare delivery.
- Debate internal and external catalysts for quality and understand the core concepts of quality and safety.
- Apply the plans to manage people, finances and organisational resources.

Unit I - Need and scopes of clinical engineering: Clinical engineering program, Educational responsibilities, Role to be performed by them in hospital, Staff structure in hospital

Unit II - National health policies: Need for evolving health policy, Health organization in state, Health financing system, Health education, Health insurance, Health legislation.

Unit III - Training and management of technical staff in hospital: Difference between hospital and industrial organization, Levels of training, Steps of training, Developing Training program, Evaluation of training, Wages and salary, Employee appraisal method.

Unit IV - Standards, codes and quality management in health care: Quality management in hospitals and clinical laboratories, Necessity for standardization and Quality management, NABH and NABL standards, FDA, Joint Commission of Accreditation of hospitals, ICRP and other standard organization, Methods to monitor the standards, Overview of Medical Device regulation and regulatory agencies.

Unit V - Computers and information technology in medicine and Healthcare: Computer application in ICU, Picture Archival System (PACS) for Radiological images department, Clinical laboratory administration, Patient data and medical records, Communication, Simulation

Reference Books

1. R.C. Goyal, "Handbook of Hospital Personal Management", Prentice Hall of India, 2008.
2. Joseph. F. Dyro, " Clinical Engineering Management", Academic Press Series in Biomedical Engineering, 2004.
3. Antony Kelly, "Strategic Maintenance planning", Butterworths London, 2006.
4. Cesar A. Caceres and Albert Zara, "The Practice of Clinical Engineering", Academic Press, 1977.
5. Webster, J.G. and Albert M. Cook, "Clinical Engineering Principles and Practices", Prentice HallInc. Englewood Cliffs, 1979.
6. Webster J.C. and Albert M.Cook, "Clinical Engineering Principle and Practice", Prentice Hall Inc., Englewood Cliffs, New Jersey, 1979.

17BM2002 BIOMEDICAL SENSORS AND TRANSDUCERS

Credits: 3:0:0

Course Objectives:

- To provide introduction to the field of medical sensors and an in depth and quantitative view of device design and performance analysis.
- To provide knowledge on the principle and operation of different medical transducers.
- To introduce the application of sensors and transducers in the physiological parameter measuring system.

Course Outcomes:

- Identify the calibration procedure for the basic instruments involved in physiological parameter measurement.
- Interpret the errors in measurement by analyzing the performance characteristics of the sensors.
- Demonstrate the appropriate sensor approach which is most likely to meet a specific biosensor application.
- Apply the suitable design criteria for developing a medical sensor for a particular application.
- Develop advanced medical sensors based on the basic transduction principles.
- Predict the qualitative performance of advanced medical sensors.

Unit I - Science of Measurement: Generalized Instrumentation System, General Properties of Input Transducer. Static Characteristics: Accuracy, Precision, Resolution, Reproducibility, Sensitivity, Drift, Hysteresis, Linearity, Input Impedance and Output Impedance. Dynamic Characteristics: First Order and Second Order Characteristics, Time Delay, Error Free Instrument, Transfer Functions. Design Criteria, Generalized Instrument Specifications.
Unit II - Different Transduction Principles: Temperature transducers, thermo resistive transducers, thermoelectric, p-n junction, chemical thermometry. Displacement transducers, potentiometric, resistive strain gauges, inductive displacement, and capacitive displacement transducer. Pressure transducer, indirect method, measurement of blood pressure using sphygmomanometer, instrument based on Korotkoff sound, strain gauge and LVDT transducers, capacitive and piezo-electric type, catheter tip transducers, measurement of intracranial pressure, catheter tip, implantable type.
Unit III - Biological Sensors: Study of various corpuscles like Pacinian, functions and modelling, Chemoreceptor, hot and cold receptors, baro- receptors, sensors for smell, sound, vision, osmolality and taste.
Unit IV - Biosensors: Introduction, Advantages and limitations, various components of Biosensors, Biocatalysts based biosensors, bio-affinity based biosensors & microorganisms based biosensors, biologically active material and analyte. Types of membranes used in biosensor constructions.
Unit V - Bio potential Electrodes and Bio Chemical Sensors: Electrodes Electrolyte Interface, Half-Cell Potential, Polarization, Polarizable and Non Polarizable, Electrodes, Calomel Electrode, Electrode Circuit Model, Electrode Skin-Interface and Motion Artifact. Body Surface Electrodes. Ion exchange membrane, electrodes, oxygen electrodes, CO_2 electrodes enzyme electrode, construction, ISFET for glucose, urea etc. Electrolytic sensors, optical sensor, fiber optic sensors. Biosensors in clinical chemistry, medicine and health care.

Reference Books

1. Medical Instrumentation-Application and Design by John G. Webster, 2013
2. Transducers for Biomedical Measurements: Principles and Applications, Richard S.C. Cobbold, John Wiley & Sons, 2004.
3. Electronics in Medicine and Biomedical Instrumentation by Nandini K. Jog PHI Second Edition 2013.
4. Instrument Transducer – An Intro to their performance and design, Hermann K P. Neubert. 4. Biomedical sensors – fundamentals and application by Harry N, Norton.
5. Biomedical Transducers and Instruments, Tatsuo Togawa, Toshiyo Tamma and P. Ake Öberg.

17BM2003 BIOMEDICAL SENSORS AND TRANSDUCERS LABORATORY

Credits: 0:0:2

Course Objectives:

- To introduce the practical aspects of various medical transducers and their characteristics.
- To impart knowledge in measurement of Resistance, Inductance and Capacitance using bridges.
- To improve the skills in calibrating analog meters.

Course Outcomes:

- Understand the method of calibration of basic instruments.
- Analyze the performance characteristics of different sensors.
- Demonstrate the appropriate sensor approach which is most likely to meet a specific biosensor application.
- Apply the suitable design criteria for developing a medical sensor for a particular application.
- Develop advanced medical sensors based on the basic transduction principles.

- Predict the qualitative performance of advanced medical sensors.

Description:

This laboratory introduces the different biomedical transducers, their working and determination of their characteristics.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HOD/Director and notify it at the beginning of each semester.

17BM2004 MEDICAL ELECTRONICS

Credits: 3:0:0

Course Objectives:

- To furnish information on the mechanisms of current flow in semi-conductors.
- To yield understanding about the basic operations of diode, transistor and their medical applications.
- To provide knowledge about advanced semiconductor devices and their significant practical applications in medical field.

Course Outcomes:

- Identify various electronic medical equipments
- Generalize the amplifiers and semiconductor applications for biosignal acquisitions.
- Apply the concepts of electronic circuits to biomedical applications.
- Categorize various application of oscillators, pulse circuits etc.
- Design practical circuits for acquisition and analysis of biomedical signals.
- Build simple circuits for biomedical signal and analysis.

Unit I - Introduction to biomedical instrumentation: Overview of medical electronic equipments, types of medical equipments, transduction of bioelectric potentials, concepts of bio-impedance.
Unit II - Introduction to semiconductor devices: PN junction diodes-VI characteristics, rectifiers, power supply design, Zener diodes, Regulators, LED, LCD, Laser diodes, Special purpose diodes and their medical applications
Unit III - BJT and its medical applications: Construction, Characteristics, Hybrid model. Transistor as amplifier, Transistor as a switch, Opto-coupler & its medical application.
Unit IV - Junction field effect transistor and its medical applications: JFET, MOSFET and its classification, Power MOSFET, MOS as a charge transferring Device – CCD, Uni-junction transistor. Medical application of MOSFET.
Unit V - Oscillators and other special purpose amplifiers: Differential amplifiers: CM and DM, feedback amplifiers, Oscillators – LC, RC, crystal and their medical application, Pulse circuits for medical devices.

Reference Books

1. Khandpur. R. S.,"Handbook of Biomedical Instrumentation", Tata McGraw-Hill, Second edition, 2003.
2. Robert L. Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory", Prentice Hall, Sixth edition, 2009.
3. David A Bell, "Electron Devices and Circuits", Prentice Hall Of India, Fifth edition, 2007.
4. Millman and Halkias, "Electronic devices and Circuits", Tata McGraw Hill, First edition, 1994.
5. Thomas L. Floyd, "Electron Devices ", Charles & Messil Publications, Tenth edition, 2009.

17BM2005 BIO SIGNAL CONDITIONING CIRCUITS

Credits: 3:0:0

Course Objectives:

- To understand bioelectric amplifiers
- To discuss filters and circuits
- To introduce application of signal conditioning in biomedical field

Course Outcomes:

- Identify the origin and characteristics of various biosignals and its acquisition.
- Identify the application of signal condition circuits for biomedical field.
- Recognize various bioamplifier for biosignal acquisitions using opamps.

- Analyze and deign bio filters and isolation circuits used in medical signal conditioning.
- Apply the concepts in designing various medical equipments using different ICs
- Interface bioelectric signals with embedded systems using digital interfaces.

Unit I - Biopotentials and bioelectric currents: Nature of Bio Electricity: Bioelectric Currents, Nernst Potential, Diffusion Potential, Action potential, Detection of Bio electric events, bio-electrode and electrode-skin interface.
Unit II - Operational Amplifiers Basic opamps parameters, Ideal and practical opamp, application of opamp in biomedicine- Adder, subtractor, analog integrator, differentiator, preamplifiers, Transimpedence circuits
Unit III - Active filters and Medical Isolation Amplifiers: First order and second order active filters, Instrumentation amplifier, Types of isolation amplifiers, and optocouplers
Unit IV - Comparators and Digital Interfaces: Comparators, Comparator applications, Multivibrators,555 timers, Astable and monostable, Pacemaker circuits, Aliaisng and sampling, Analog to Digital, Digital to Analog conversion, Biosignal data acquisition systems
Unit V - Special analog circuits and systems used in biomedical Instrumentation: Phase Detectors-Analog and Digital, Voltage Controlled Oscillators, Various VCO ICS, Phase locked loops. Electrical Interface problems and Safety Standards in Bio Potential Measurements.

Reference Books

1. Robert B. Northrop, "Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation", CRC Press, II Edition, New York,2004.
2. Myer Kutz, "Biomedical Engineering and Design Handbook", II Edition, Volume 1, McGraw Hill Professional, 2009.
3. Milman & Hallkias, "Integrated Electronics-Analog and Digital Circuit", McGraw Hill, II Edition, 2011.
4. Robert F. Coughlin, Frederick F. Driscoll, "Operational Amplifiers & Linear Integrated Circuits", Prentice-Hall, 6th Edition,2001.
5. Sergio Franco, "Design with Operational Amplifier and Analog Integrated Circuits", TMH, 3rd Edition, 2002.

17BM2006 BIOSIGNAL CONDITIONING CIRCUITS LABORATORY

Credits: 0:0:2

Course Objectives:
- To understand the design of filters and circuits for bioelectric amplifiers.
- To impart knowledge of the different preamplifiers used for amplifying the bio signals.
- To impart knowledge about the application of signal conditioning in biomedical field.

Course Outcomes:
- Apply and analyze the front end analogue circuit design for ECG, EMG, EEG, etc.
- Identify the method to apply various signal conditioning circuits.
- Apply the basic concepts of filtering and signal acquisitions for bio signals
- Identify the amplifiers for a variety of biomedical sensors.
- Design and build various digital interfaces for embedded applications
- Select suitable circuits to design various biomedical devices

Description:
This laboratory introduces the filter design and circuit design for bioelectric amplifiers.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HOD/Director and notify it at the beginning of each semester

17BM2007 BIOCONTROL SYSTEMS

Credits: 3:0:0

Course Objectives:
To study various
- Bio control systems modeling technique.
- Time response analysis and frequency response analysis.

- Analyze biological control systems.

Course Outcomes:

- Represent the system in various forms.
- Compute the mathematical model of physiological systems.
- Interpret the response of the system in time domain.
- Analyze the frequency response of any system
- Examine the stability of the system.
- Summarize the features of physiological system.

Unit I - Basic structure of control system, Positive and Negative Feedback, transfer functions, modeling of electrical systems, block diagram and signal flow graph representation of systems

Unit II - Difference between engineering and physiological control systems, generalized system properties , models with combination of system elements. Physiological system modeling, Linear model of respiratory mechanics, model of chemical regulation of ventilation, linear model of muscle mechanics, model of regulation of cardiac output, model of Neuromuscular reflex motion

Unit III - Introduction to simulation, Step response of first order and second order systems, determination of time domain specifications of first and second order systems. Definition of steady state error constants and its computation

Unit IV - Frequency response, determination of gain margin and phase margin using Bode plot, use of Nichol's chart to compute resonant frequency and band width.

Unit V - Definition of stability, Routh-Hurwitz criteria of stability, construction of root locus, Nyquist stability criterion, Nyquist plot and determination of closed loop stability

Reference Books

1. Michael. C. K. Khoo, "Physiological control systems", IEEE press, Prentice –Hall of India, 2001.
2. Benjamin C. Kuo, "Automatic control systems", Prentice Hall of India,7th edition, 1995
3. M. Gopal "Control Systems Principles and design", Tata McGraw Hill ,2002
4. John Enderle, Susan Blanchard, Joseph Bronzino, "Introduction to Biomedical Engineering" second edition, Academic Press, 2005.
5. Richard C. Dorf, Robert H. Bishop," Modern control systems", Pearson, 2004.

17EI2008 MEDICAL DIAGNOSTIC EQUIPMENT

Credits: 3:0:0

Course objectives:

- To know the principle of various bio potential recordings equipment.
- To understand the working of equipment used for physiological parameters.
- To learn the diagnostic equipment for clinical and advanced equipment.

Course outcomes:

- Identify the procedures for acquisition of physiological signals
- Demonstrate the functions and applications of diagnostic equipment
- Construct the suitable measurement systems and its signal conditioning circuits
- Compare the techniques for clinical diagnosis and its recent methods
- Assess the merits of the diagnostic equipment based on its applications
- Design the devices for the particular application based on given specifications.

Unit I - Equipment for physiological signals acquisition: Electrocardiography, Electro encephalography, Electro Oculography, Electro myography, Electro gastrography.

Unit II - Vital parameter monitoring system: Measurement of human body temperature, blood pressure monitor, body mass index, Heart rate, respiration rate, oxygen saturation.

Unit III - Equipments for non invasive methods: Pulse oximeter, spirometer, measurements for respiration gas flow, cardiac output, blood flow meter and signal conditioning circuits.

Unit IV - Clinical equipments: Bio-chemical measurement:Blood pH, Blood pO2, Blood pCO2, glucometer, hemoglobin monitor, Photometers, chromatograph.

Unit V - Advanced equipments: Ultrasound scanner, holter monitor, multi parameter monitor, capsule endoscopy, foot scanner.

Reference Books

1. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology",Pearson Education India, Delhi, 2004.
2. Khandpur. R. S., "Handbook of Biomedical Instrumentation", Prentice Hall of India, New Delhi, 2003.
3. Cromwell, "Biomedical Instrumentation and Measurements", Prentice Hall of India, New Delhi, 2007.
4. Webster, "Medical Instrumentation – Application & Design," John Wiley and sons Inc, Netherlands, 2009.
5. Jacobson B and Webster J G Medical and Clinical Engineering – Prentice Hall of India New Delhi 1999

17BM2009 BIOMECHANICS PROSTHESIS AND ORTHOSIS

Credits: 3:0:0

Course Objectives:

- To introduce the fundamental terms and concepts of human system modeling.
- To understand the anthropometric, biomechanical and physiological principles and their use in human well-being and overall performance.
- To acquire knowledge in evaluation of physiological factors and fitness factors for vehicle drivers.

Course Outcomes:

- Recognize the concepts of human system modelling.
- Interpret the human factors that affect the environmental conditions
- Apply the engineering tools in design of prosthetics
- Analyze the data, design, and functions of orthotics and overall performance.
- Evaluate the methods, solutions to human problems for specific needs
- Design the advanced system concepts implement solutions to a human factors problem.

Unit I - Human system modeling: Human control of systems, biomechanics-stress and fatigue measurements of bones, muscles-cognitive stress-stress modeling- signal acquisition and processing-brain and computer interface.
Unit II - Effects of environmental conditions: Human Factors Applications in medical and industrial field, Heat, stress-Human error- accidents analysis- human factors –case study on evaluation of the physiological factors and fitness factors for defense vehicle driver –safety Standards.
Unit III - Prosthesis: Introduction to Prosthesis, -Gait Analysis in Transtibial Amputees, Prosthesis in Knee Disarticulation- Gait Analysis in Transfemoral Amputees, -Prosthesis for Hand Amputation and Wrist Disarticulation-Recent Advances in Prosthesis
Unit IV - Orthotics: Introduction to orthotics, applications, implants, design of orthotics, modeling and analysis, 3D printing, A support, brace, or splint used to support, the function of movable parts of the body.
Unit V - Introduction to robotics: Definition - Classification - History - Robots components - Degrees of freedom - Robot joints coordinates - Reference frames - Workspace - Robot languages - Actuators - Sensors - Sensor characteristics - and electric actuators

Reference Books

1. Subrata Pal, "Text book of Biomechanics", Viva education Private limited, New Delhi. 2009.
2. Saeed B. Niku , "Introduction to Robotics", Pearson Education, 2002.
3. K.S.Fu, Ralph Gonzalez and C.S.G.Lee, "Robotics", TATA McGraw Hill, Aug., 2008.
4. Susan J.Hall, "Basics Bio Mechanics" 5th Edition, McGraw-Hill Publishing Co, Newyork, 2007.
5. Joseph D. Bronzino, "The biomedical engineering handbook", Volume 2, CRC Press, USA, 2000.

17BM2010 BIOSIGNAL PROCESSING LABORATORY

Credits: 0:0:2

Course Objectives:

- To record the bio signals and analyze it.

- To study the different preamplifiers used for amplifying the bio signals.
- To impart knowledge about the measurements and recordings of bioelectric and biochemical signals.

Course Outcomes:

- Recall the fundamentals of signal processing concepts.
- Recognize the morphological features of a signal.
- Apply the signal processing algorithms for real time bio-signals.
- Analyze the characteristics of the signal.
- Design digital filters for bio signal processing.
- Select suitable digital signal processors for processing a signal.

Description:

This laboratory introduces the different digital filters, sampling process and signal processing algorithms suitable for pre-processing the bio signals.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HOD/Director and notify it at the beginning of each semester

17BM2011 MEDICAL THERAPEUTIC EQUIPMENT

Credits: 3:0:0

Course objectives:

- To learn the principles of cardiac assist devices.
- To understand the need and use of extracorporeal devices, and the use of lasers in medicine.
- To enable the students to gain knowledge on the working of therapeutic clinical equipment.

Course outcomes:

- Identify the various therapeutic devices available for specific diseases.
- Demonstrate the functions and applications of cardiac, respiratory and electrotherapy equipment.
- Apply the appropriate therapeutic device for a particular ailment.
- Compare the techniques used in hospitals and its recent advancements.
- Assess the merits and demerits of the therapeutic equipment based on its applications.
- Design new therapeutic devices for particular application based on given specifications.

Unit I - Cardiac Equipment: External and implantable pacemakers, Programmable pacemakers, Power sources, Design of encapsulation and leads, Pacing system analyzers. Cardiac Defibrillators, Basic principles and comparison of different Defibrillators, Energy requirements, Synchronous operation, Implantable Defibrillators, Defibrillator analyzers.

Unit II - Respiratory Equipment: Principles of constant pressure and constant volume ventilators, Basic principles of electromechanical, Pneumatic and electronic ventilators, Nebulizer, Ventilator testing.

Unit III - Electrotherapy Equipment – I: Electro diagnosis, Electrotherapy, Electrodes, Stimulators for Nerve and Muscle, Stimulator for pain relief, Interferential current therapy, Spinal cord stimulator, Diaphragm pacing for artificial ventilation. Functional Electrical Stimulation.

Unit IV - Electrotherapy Equipment – II: High frequency heat therapy, Principle, Short wave diathermy, Microwave diathermy, Ultrasonic therapy, Lithotripsy, Therapeutic IR radiation, Therapeutic UV Lamps.

Unit V - Therapeutic Lasers: Basic principles of Biomedical LASERS: Applications of lasers in medicine, CO_2 laser, He-Ne laser, Nd-YAG and Ruby laser.

Reference Books

1. Khandpur. R.S., "Handbook of Biomedical Instrumentation". Second Edition. TataMc Graw Hill Pub. Co.,Ltd. 2013.
2. John. G. Webster. "Medical Instrumentation, Application and Design".Fourth Edition. Wiley &sons, Inc.,New York.2011.
3. Leslie Cromwell, Fred. J. Weibell & Erich. A. Pfeiffer. "Biomedical Instrumentation and Measurements". Second Edition. Prentice Hall Inc.2000.
4. JohnLow & AnnReed. "Electrotherapy Explained, Principles and Practice". Second Edition. Butterworth Heinemann Ltd. 2000.

5. Joseph. J. Carr, John Michael Brown, "Introduction to Biomedical Equipment Technology", Prentice Hall and Technology, 2008.

17BM2012 BIOMEDICAL INSTRUMENTATION LABORATORY

Credits: 0:0:2

Course Objective:

- To record the bio signals and analyze it.
- To study the different preamplifiers used for amplifying the bio signals.
- To impart knowledge about the measurements and recordings of bioelectric and biochemical signals.

Course Outcome:

- Calibrate medical instruments.
- Identify the suitability of diagnostic and therapeutic equipment for specific applications.
- Analyze the performance of various biomedical equipment and infer their safety aspects.
- Apply appropriate measurement techniques.
- Design portable instruments capable of recording bio signals.
- Evaluate the performance of medical instruments.

Description:

This laboratory introduces the different diagnostic and therapeutic equipment, their working and the methodologies used for analysing and recording bio signals.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HOD/Director and notify it at the beginning of each semester.

17BM2013 MODELLING OF PHYSIOLOGICAL SYSTEMS

Credits: 3:0:0

Course objectives:

- To learn the basic ideas related to modeling.
- Understand different modelling techniques of physiological systems.
- To study the various regulatory systems of the human body.

Course Outcomes:

- Analyze the concepts of modeling
- Differentiate the dynamics of circulatory system
- Perform the modeling for thermal regulatory system
- Design the model for Renal system
- Evaluate the mass-balance concept for respiratory system
- Summarize the mathematical concept for any Physiological system

Unit I - Basics of Physiological Systems: Systems Analysis, examples of physiological control systems, differences between engineering and physiological control systems. Generalized system properties, mathematical approach, electrical analogs, linear models, lung mechanics, muscle mechanics, distributed parameter versus lumped parameter models, static analysis, regulation of cardiac output, blood glucose regulation, chemical regulation of ventilation, electrical model of neural control mechanism

Unit II - Circulatory System: Physical, chemical and rheological properties of blood, problems associated with extra corporeal blood flow, dynamics of circulatory system.

Unit III - Thermal Regulatory System: Parameters involved, Control system model etc. Biochemistry of digestion, types of heat loss from body, models of heat transfer between subsystem of human body like skin core, etc. and systems like within body, body, environment, etc.

Unit IV - Ultra-Filtration System: Transport through cells and tubules, diffusion, facilitated diffusion and active transport, methods of waste removal, counter current model of urine formation in nephron, Modeling Henle's loop.

Unit V - Respiratory System: Modelling oxygen uptake by RBC and pulmonary capillaries, Mass balancing by lungs, Gas transport mechanisms of lungs, oxygen and carbon dioxide transport in blood and tissues

Reference Books

1. David O. Cooney. (2000). Biomedical Engineering Principles. Marcel Decker Pub. Co.
2. Michael C.K.Khoo. (2000). Physiological Control Systems. Prentice Hall of India.
3. John Enderly, Susan Blanchard, Joseph Bronzino. (2005). Introduction to Biomedical Engineering. Second Edition, Academic Press Series in Biomedical Engineering.

17BM2014 MEDICAL IMAGING TECHNIQUES

Credits: 3:0:0

Course Objectives:

- To study the quality assurance test for radiography, method of recording sectional images
- To study the functioning of radio isotopic imaging equipment.
- To study the MRI, image acquisition and reconstruction

Course Outcomes:

- List out the various medical imaging techniques.
- Explain the principle of specific medical imaging techniques.
- Interpret the imaging outputs.
- Identify the suitable medical imaging techniques for specific pathology.
- Devise new ideas to solve certain issues in medical imaging.
- Justify the impact of medical imaging system for diagnosis.

Unit I - ULTRASOUND IN MEDICINE: Production of ultrasound – properties and principles of image formation, capture and display – principles of A-mode, B-mode and M-mode display – Doppler ultra sound and color flow mapping – applications of diagnostic ultra sound.

Unit II - X-RAY COMPUTED TOMOGRAPHY: Principles of sectional imaging – scanner configuration – data acquisition system – image formation principles – conversion of x-ray data in to scan image – 2-D image reconstruction techniques –Iteration and Fourier method – types of CT scanners.

Unit III - MAGNETIC RESONANCE IMAGING: Principles of MRI pulse sequence – image acquisition and reconstruction techniques – MRI instrumentation magnetic gradient system RF coils – receiver system functional MRI – Application of MRI.

Unit IV - RADIO ISOTOPIC IMAGING: Rectilinear scanners – linear scanners – SPECT – PET Gamma camera radio nuclides for imaging – emission computed CT 78.

Unit V - INFRA RED IMAGING: Physics of thermography – imaging systems – pyroelectric Videocon camera clinical thermography – liquid crystal thermography.

Reference Books

1. M. Analoui, J.D. Bronzino, D.R.Peterson, "Medical Imaging: Principles and Practices", CRC Press, 2012.
2. S. Webb, "Physics of medical imaging", Taylor & Francis, 2010.
3. T. Farncombe, K. Iniewski, "Medical Imaging: Technology & Applications", CRC Press, 2013
4. J.S. Benseler, "The Radiology Handbook: A pocket guide to medical imaging", Ohio University Press, 2006
5. R.R.Carlton, A.M.Adler, "Principles of Radiographic Imaging: An Art and a Science", Delmar Cengage Learning; Fifth Eddition, 2012
6. N.B.Smith, A. Webb, "Introduction to Medical Imaging Physics, Engineering and Clinical Applications" CRC Press, 2010
7. M.A. Haidekker, "Medical Imaging Technology", Springer, 2013

17BM2015 DIGITAL IMAGE PROCESSING FOR MEDICAL APPLICATION

Credits: 3:0:0

Course Objectives:

- Learn digital image fundamentals.
- Be exposed to simple image processing techniques.
- Be familiar with image compression and segmentation techniques.

Course Outcomes:

- Describe various concepts of digital image processing
- Select suitable technique for accomplishing specific image processing task
- Illustrate the steps involved in processing digital images
- Analyze the performance of image processing techniques
- Devise new ideas or tools to solve common issues in certain applications
- Assess the impact of digital image processing for medical application

Unit I - Digital image fundamentals: Introduction – Origin – Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels - color models.

Unit II - Image enhancement: **Spatial Domain:** Gray level transformations – Histogram processing – Basics of Spatial Filtering–Smoothing and Sharpening Spatial Filtering – **Frequency Domain:** Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters.

Unit III - Image restoration and segmentation: Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering **Segmentation:** Detection of Discontinuities–Edge Linking and Boundary detection – Region based segmentation- Morphological processing- erosion and dilation.

Unit IV - Wavelets and image compression: Wavelets – Subband coding - Multiresolution expansions - **Compression:** Fundamentals – Image Compression models – Error Free Compression – Variable Length Coding – Bit-Plane Coding – Lossless Predictive Coding – Lossy Compression – Lossy Predictive Coding – Compression Standards.

Unit V - Image representation and recognition: Boundary representation – Chain Code – Polygonal approximation, signature, boundary segments – Boundary description – Shape number – Fourier Descriptor, moments- Regional Descriptors – Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching.

Reference Books

1. Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", Third Edition, Pearson Education, 2010.
2. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using Matlab", Third Edition Tata McGraw Hill Pvt. Ltd., 2011.
3. Anil Jain K. "Fundamentals of Digital Image Processing", PHI Learning Pvt. Ltd., 2011.
4. William K. Pratt, "Introduction to Digital Image Processing", CRC Press, 2013.
5. Chris Solomon, Toby Breckon, "Fundamentals of Digital Image Processing – A practical approach with examples in Matlab", Wiley-Blackwell, 2010.
6. Jayaraman, "Digital Image Processing", Tata McGraw Hill Education, 2011.
7. Malay K. Pakhira, "Digital Image Processing and Pattern Recognition", First Edition, PHI Learning Pvt. Ltd., 2011.

17BM2016 EMBEDDED BIOMEDICAL INSTRUMENTATION SYSTEMS

Credits: 3:0:0

Course Objectives:

- To study the fundamentals of embedded system and its hardware units.
- To study the concepts of various programming models for embedded system design
- To study the development activities of real time biomedical instrumentation system for medical applications

Course Outcomes:

- Identify the basic need of embedded systems and various software development tools
- Classify the different program modelling concepts for real time system design
- Choose the suitable techniques for biomedical instrumentation system application development
- Demonstrate various interfacing issues related to real time embedded applications
- Point out the requirement of RTOS for multitasking execution
- Design embedded based biomedical system for remote applications

Unit I - Introduction to embedded systems: Embedded system, Processor embedded into a system, embedded hardware units – Embedded software in a system – Conversion of assembly language into machine codes – Software tools for designing an embedded systems – Examples of an embedded systems – Complex systems design and processors – Design process in embedded system – Classification of an embedded systems

Unit II - Program modeling concepts: Program modeling concepts –State machine programming model- State Machine and state Tables in embedded design – Modelling for multiprocessor systems – UML modeling – High level language descriptions of S/W for embedded system – Software programming – Object oriented programming – Embedded programming advantages and disadvantages

Unit III - Interfacing techniques for system design: Getting embedded software into a target system, Simulation and Emulation of an embedded system, Software development tools-Overview of analog and digital Interfacing-LED, Seven Segment Display, Switch Interface, Keypad Interface, Data Acquisition system- Analog to Digital and Digital to analog converters, Timer operations. Pressure sensor interfacing, Temperature sensor interfacing and serial communications

Unit IV - Real time multitasking system: Real time languages , OS tasks, Task states, Real time kernel, Preemptive Kernel, Non preemptive kernel, Priority Inversion Problem, Task scheduling, Interrupt Service Routine in RTOS environment.

Unit V - Applications: Computerised versions of ECG, EEG, EMG Acquisitions - Embedded implementation of physiological parameters monitoring system, Role of body sensor networks for biomedical applications, Study of wireless modules for biomedical applications- Case studies in medical signal and image processing, Design of embedded system for classifying and diagnosis of various diseases.

Reference Books

1. RajKamal, "Embedded Systems Architecture, Programming and Design", Tata McGrawHill , Second Edition, 2008.
2. Tim Wilhurst, "An Introduction to the Design of Small Scale Embedded Systems, Palgrave, 2004.
3. Tammy Noergaard, "Embedded Systems Architecture", Elsevier, 2005.
4. Frank Vahid, Tony Givargis, "Embedded Systems Design", Wiley India, 2006

17BM2017 EMBEDDED BIOMEDICAL INSTRUMENTATION SYSTEMS LABORATORY

Credits: 0:0:2

Course Objectives:

- To impart the basic knowledge about embedded systems.
- To learn about the Embedded Processors with Real World applications.
- To understand the concepts of embedded programming.

Course Outcomes:

- List different software tools used for system design
- Review the structure of embedded software and download it to the embedded hardware.
- Demonstrate the necessary of embedded hardware and the interface issues related to it.
- Identify the various procedures for designing real time system
- Design a real time biomedical system for real time bio signal acquisitions
- Summarize the programming issues related to biomedical instrumentation system

Description:

This course enables the students to gain practical knowledge in embedded programming, data acquisition and interfacing techniques of medical sensors and instruments with microcontrollers and apply it to real time applications.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HOD/Director and notify it at the beginning of each semester.

17BM2018 BIOVIRTUAL INSTRUMENTATION LABORATORY

Credits: 0:0:2

Course Objectives:

- To study the basic programming concepts of virtual instrumentation.
- To study the various functions available to process and extract features from bio signals.
- To learn about real time data acquisition and medical sensors interfacing concepts.

Course Outcomes:

- Create, edit and debug bio virtual instruments.
- Understand the usage of biomedical tool kit for processing bio signals.
- Develop virtual instrumentation systems for filtering and processing of bio signals.
- Apply computer interfacing principles for bio signal acquisition.
- Interpret the merits of real time processing of data using LabVIEW.
- Appraise the usefulness of LabVIEW in real time data acquisition and processing of bio signals which aids in measurement of physiological data and analysis.

Description:

This course enables the students to gain practical knowledge in programming techniques, data acquisition and interfacing techniques of virtual instrumentation and apply it to real time environment.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HOD/Director and notify it at the beginning of each semester.

17BM2019 MEDICAL IMAGE PROCESSING LABORATORY

Credits: 0:0:2

Course Objectives:

- To teach about the image processing tool
- To impart hands-on knowledge on various image processing techniques
- To apply for biomedical image applications.

Course Outcomes:

- Describe various components of digital image processing tool
- Select suitable technique for implementing specific image processing task
- Illustrate the steps involved in processing digital images
- Analyze the results of image processing algorithms
- Devise new approach to solve issues in certain applications
- Assess the impact of digital image processing tool for medical application

Description:

This course enables the students to gain practical knowledge in medical image processing techniques, using various algorithms.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HOD/Director and notify it at the beginning of each semester.

17BM2020 SURGICAL ASSIST SYSTEMS

Credits: 3:0:0

Course objectives:

- Understand the need for robotics based assistive devices
- Learn robot kinematics, trajectory control
- Apply control algorithms in controlling robot motion for medical applications

Course Outcomes:

- Identify the concepts of robotics, motion, joints
- Summarize the principles of sensors and actuators for robots
- Use the software tools for designing and analysing the robot motion
- Classify the performance to various sensors to its environment

- Recommend the suitable principles for specific conditions
- Create simple robots for surgical applications

Unit I - Introduction to Robotics: Degree of freedom, path planning, Lagrange equation of motion, kinetics, payload.
Unit II - Robot sensors, actuators: Sensors and actuators, gripper- types, applications. Proximity switches,
Unit III - Mechanism: Lift mechanism for surgery, special lighting controls, ventilator, and heart lung machine.
Unit IV - Controllers: Artificial intelligence, machine vision, design of controllers.
Unit V - Human machine interface: Surgical conditions, types of surgeries by robots, camera, wireless devices, remote monitors, case studies.

Reference Books

1. Jacob Rosen, Blake Hannaford, Richard. M. Satava, "Surgical Robotics- Systems, Applications and Visions", Springer, 2010.
2. Farid Gharagozloo, Farzad Najam, "Robotic surgery", McGraw Hill Publishers, US, 2009,
3. Bruno Siciliano and Lorenzo Sciavicco, "Robotics: Modelling, Planning and Control, Springer, 2010.
4. Bruno Siciliano, Oussama Khatib, "Springer Handbook of Robotics", Springer, 2008.
5. Sebastian Thrun, Wolfram Burgard, "Probabilistic Robotics", Intelligent Robotics and Autonomous Agents series, 2005.

17BM2021 SENSORY AND MOTOR REHABILITATION

Credit: 3:0:0

Course Objectives:

- Know the fundamental rehabilitation concepts for future development and applications.
- Understand orthopedic prosthetics and orthotics in rehabilitation.
- Apply the technology to improve the quality of life of the disabled population.

Course Outcomes:

- Identify the models of rehabilitation
- Interpret the techniques for disabilities related to sensory and motor functions
- Construct the test bench, tools and methods for troubleshooting
- Compare various standards and specifications.
- Decide quality and safety standards in design of devices for user needs
- Formulate advanced methods to solve critical problems related to old aged

Unit I - Rehabilitation concepts: Engineering concepts in sensory rehabilitation, motor rehabilitation. Survey.
Unit II - Sensory Rehabilitation: Rehabilitation of auditory disorders, and vision, measurement system, rehabilitation methods- Hearing aids and other assistive devices. Language disorders, assessment and treatment.
Unit III - Motor Rehabilitation: Limb disorder, fractures, mobility aids, assist devices, types, prosthetics, myoelectric arm.
Unit IV - Cognitive Rehabilitation: Cognitive disorder, assessment, design of communication aids, assist devices for cognitive development, evaluation of improvements.
Unit V - Rehabilitation for Old aged: Assist devices for old aged, assist devices for lifting, standing, movement, monitoring systems, movement sensor, Case study.

Reference Books

1. Horia, Hicholi, Teodorescu L., Lakme C Jain., "Intelligent Systems and Technologies in Rehabilitation Engineering", First Edition. CRC Press. 2000.
2. Bronzino J.D., "The Biomedical Engineering handbook". Second Edition. Vol. II, CRC press, Bocaraton, 2000.
3. Cooper Douglas, A. Hobson, "An Introduction to Rehabilitation Engineering", CRC Press, 2007.
4. Marion A. HershBy Jerome G. Alpiner, Patricia A. McCarthy, "Assistive Technology for Visually Impaired and Blind People", CRC Press, 2005.

17BM2022 MEDICAL EQUIPMENT MAINTENANCE AND TROUBLESHOOTING

Credits: 3:0:0

Course Objectives:

- Understand troubleshooting of electrical and electronic equipment.
- Learn the trouble shooting of medical equipment.
- Apply the tools in design, testing and developing medical equipment

Course Outcomes:

- Identify the reasons for equipment failure.
- Interpret the need for grounding aspects, maintenance and troubleshooting.
- Construct the test bench, tools and methods for troubleshooting
- Compare various standards and specifications.
- Decide quality and safety standards
- Formulate advanced methods to solve critical problems.

Unit I - Testing of electrical equipments: AC, DC power supply, Grounding, shielding, Guarding, insulation testing, insulation resistance measurement, Types of Circuit Breakers, Rating - Testing of circuit breakers – Tranformer testing- Earthing –Earth wires - Earthing of appliances – contactor, relay testing–CT and PT, Panel wiring- Megger-Testing equipments and instruments.

Unit II - Testing of electronic components: Troubleshooting of PCB boards, Calibration of analog and digital sensor probe, Display interface, DC Power supply design, testing, Safe electrical practice, Cables and standard, Fuse.

Unit III - Testing of surgical Equipment: Functions and operating procedure-Testing and maintenance of Heart lung machine, surgical lights, ventilator, patient monitor, anesthesia machine, dialyzer, surgical tools.

Unit IV - Troubleshooting of equipments: X-ray machines, Troubleshooting of ECG recorders, incubator, baby warmer, infusion pumps, annual maintenance, contract requirements, vendor services, quality and safety standards.

Unit V - Life cycle management of medical equipment: Cost of the medical equipment, maintenance cost, replacement analysis, managing equipment service, decision making, extracting optimal benefit from medical equipment over its life cycle. Case study.

Reference Books

1. Shakti Chatterjee, Aubert Miller, "Biomedical Equipment Repair", Cengage Learning Technology & Engineering, 2010.
2. David Herres, "Troubleshooting and Repairing Commercial Electrical Equipment", McGraw Hill Professional edition, 2013.
3. Rao S, "Testing, Commissioning, Operation and Maintenance of Electrical Equipment", Khanna Publishers, New Delhi, 2014.
4. L.Nokes.B.Turton, D.Jennings, T. Flint, "Introduction to Medical Electronics Applications", Butterworth Heinemann, Pub., New Delhi. 1995.
5. Francis Hegarty, John Amoore, "Health care technology management – A systematic approach", CRC Press, USA, 2017.
6. Paul Gill, "Electrical Power Equipment Maintenance and Testing", CRC Press, USA, Second Edition, 2008.
7. Hemant Joshi, "Residential, Commercial and Industrial Electrical Systems: Protection, testing and commissioning", Tata McGraw-Hill Education, New Delhi,2008.
8. Medical Equipment Maintenance Manuel, Ministry of Health and Family Welfare, New Delhi, 2010.

17BM2023 BIOMEDICAL OPTICS

Credit 3:0:0

Course Objective:

- To offer clear understanding of tissue characteristics when it is exposed to optical energy.
- To know about various optical sources and applications of lasers.
- To learn about Holography and its medical applications.

Course Outcomes:

- Recall the principles of optical properties
- Explain the different measurement techniques in medical optics
- Illustrate the concept of biomedical optics in various real life applications
- Analyze the instrumentation involved in biomedical optics
- Apply laser instrumentation in medical diagnosis and therapy
- Discuss the therapeutic applications in the field of medicine

Unit I - Optical properties of the tissues: Refraction, Scattering, Absorption, Light transport inside the tissue, Tissue properties, Laser Characteristics as applied to medicine and biology-Laser tissue Interaction-Chemical-Thermal- Electromechanical – Photoabalative processes.
Unit II - Instrumentation in photonics: Instrumentation for absorption, Scattering and emission measurements, excitation light sources – high pressure arc lamp, LEDs, Lasers, Optical filters, - optical detectors – Time resolved and phase resolved detectors.
Unit III - Laser applications: Lasers in ophthalmology- Dermatology –Dentistry-Urology-Otolaryngology - Tissue welding.
Unit IV - Non thermal diagnostic applications: Optical coherence tomography, Elastography, Laser Induced Fluorescence (LIF)-Imaging, FLIM Raman Spectroscopy and Imaging, FLIM – Holographic and speckle application of lasers in biology and medicine.
Unit V - Therapeutic applications: Phototherapy, Photodynamic therapy (PDT) - Principle and mechanism - Oncological and nononcological applications of PDT - Biostimulation effect – applications-Laser Safety Procedures.

Reference Books

1. Markolf H.Niemz, "Laser-Tissue Interaction Fundamentals and Applications", Springer, 2007
2. Paras N. Prasad, "Introduction to Biophotonics", A. John Wiley and Sons, Inc. Publications, 2004

17BM2024 BIOMETRIC SYSTEMS

Credits: 3:0:0
Course Objective:

- To introduce the basic concepts of fingerprint, iris, face and speech recognition.
- To impart knowledge on the general principles of design of biometric systems and the underlying trade-offs
- To render knowledge on personal privacy and security implications of biometrics based identification technology and the issues realized

Course Outcome:

- Infer the technologies of fingerprint, iris, face and speech recognition.
- Expertise in the general principles of design of biometric systems and the underlying trade-offs.
- Priorities the work on identification and recognition depends on physiological and behavioral characteristics
- Identifying the interfacing technologies for real time biometric applications
- Inculcate knowledge on personal privacy and security implications of
- Biometrics based identification technology and the issues involved.

Unit I - Biometric Fundamentals – Definition: Biometrics versus traditional techniques – Characteristics - Key biometric processes - Verification - Identification - Biometric matching - Performance measures in biometric systems - Assessing the privacy risks of biometrics.
Unit II - Physiological Biometrics Characteristics: Facial scan - Ear scan, Retina scan -
Iris scan - Finger scan - automated fingerprint identification system - Palm print - Hand vascular geometry analysis - DNA - Dental.
Unit III - Behavioural Biometrics Characteristics: Signature scan - Keystroke scan - Voice scan, Gait recognition - Gesture recognition - Video face - mapping the body technology.
Unit IV - Biometric Interfaces: Human machine interface - BHMI structure, Human side interface: Iris image interface - Hand geometry and fingerprint sensor - Machine side interface - Parallel port - Serial port - Network topologies.

Unit V - Biometric Applications: Categorizing biometric applications, Application areas: Criminal and citizen identification – Surveillance - PC/network access - E-commerce and retail/ATM - Costs to deploy - Issues in deployment - Biometrics in medicine - cancellable biometrics.

Reference Books

1. James Wayman, Anil Jain, DavideMaltoni, Dario Maio, "Biometric Systems, Technology Design and Performance Evaluation", Springer, 2005
2. S.Y. Kung, S.H. Lin, M.W.Mak, "Biometric Authentication: A Machine Learning Approach" Prentice Hall, 2005
3. Paul Reid, "Biometrics for Network Security", Pearson Education, 2004.
4. Nalini K Ratha, Ruud Bolle, "Automatic fingerprint Recognition System", Springer, 2003
5. L C Jain, I Hayashi, S B Lee, U Halici, "Intelligent Biometric Techniques in Fingerprint and Face Recognition" CRC Press, 1999.
6. Sanir Nanavati, Michael Thieme, Biometrics Identity Verification in a Networked world, Wiley Computer Publishing Ltd, New Delhi,2003.
7. Paul Reid, "Biometrics for Network Security", Pearson Education, New Delhi, 2004.
8. Ruud M. Bolle et al, "Guide to Biometrics", Springer, USA, 2003.
9. David D Zhang, "Automated Biometrics: Technologies and Systems", Kluwer Academic Publishers, New Delhi, 2005

17BM2025 RADIATION AND NUCLEAR MEDICINE

Credits: 3:0:0

Course Objectives:

- To expose the student to the use of ionizing radiation and its biological effects in the medical field.
- To know about the use of ionizing radiation in medical and industrial applications.
- To understand the biological effects of low and high doses of ionizing radiation.

Course Outcomes:

- Acquire knowledge about radiation activity in the living cells.
- Identify the key principles of nuclear medicine and radioactivity.
- Analyze the working principle of advanced nuclear medicine imaging systems.
- Interpret the effects of ionizing and non-ionizing radiations
- Analyze the effect of microwave on human organs and systems.
- Suggest suitable therapeutic radiation for diseases without any side effects.

Unit I - Action of Radiation in Living Cells: Various theories related to radiation at cellular level. Dna and chromosomal damages. Somatic application of radiation. Radio sensitivity protocols of different tissues of human. Ld50/30 effective radiation on skin, bone marrow, Eye, endocrine glands, and basis of radio therapy. Genetic effects of radiation: Threshold and linear dose, gene control hereditary diseases effect of dose. Effect of microwave: Effects on various human organs and systems.

Unit II - Nuclear Medicine: Basic characteristic and units of radioactivity, ionization chamber, GM tubes, Gas filled detectors, scintillation detectors, semiconductor detectors, Liquid scintillation counter, Statistical aspects of nuclear medicine.

Unit III - Nuclear Medicine Imaging Systems: Rectilinear scanners, Scintillation Camera, principle of operation, collimator, photomultiplier tube, Pulse height Analyser, computerized multi crystal Gamma camera, Principles of PET and SPECT.

Unit IV - Radiation Therapy: Principles of Radiation Therapy, Radio therapy treatment planning Dose in Radiotherapy, Mega voltage therapy, Intensity modulated Radiation therapy, Brachy-therapy, Radiotherapy using radio isotopes

Unit V - Radiobiology and Radiological Protection: Radiation sensitivity of biological materials, Evidence on radiobiological damage from cell survival curve, Radiation effects on humans, Maximum permissible dose equivalent limits, Hazard from ingested radioactivity, substances, ICRP regulations, Quality factor and sievert, Principles of radiological protection, personnel dosimetry.

Reference Books

1. Mary Alice S, Paula J Visconti, E Russell Ritenour, Kelli Haynes," Radiation Protection In medical Radiography,"Elsevier Health Sciences,2014.
2. Glasser O.,"Medical Physics", Volume I,II,III, The year book publishers inc, chicago 1980.
3. Moselly H., "Non ionizing radiation", Adam-hilgar, Bristol 1988.
4. Khan,F.M, Physics for Radiation Therapy, Williams & Wilkins. 2009.
5. Gopal B.Saha, Physics and Radiation biology of Nuclear Medicine. 2006

17BM2026 PATIENT AND DEVICE SAFETY

Credits: 3:0:0

Course Objectives:

- To provide a source of useful ideas, concepts, and techniques that could be selectively applied to reduce an intolerable rate of unacceptable errors, mistakes, goofs, or short comings in expected Medical Device performance.
- To avoid patient injury, achieving efficacious treatment, and controlling health care costs.
- Medical error has proved to be a difficult and recalcitrant phenomenon.

Course Outcomes:

- Identify the mechanical and electrical safety standards of medical equipment
- Understand device specific safety goals
- Interpret reasonable, acceptable and effective remedies and counter measure
- Access the clinical suitability to under the impact of the device on the environment
- Device more reliable medical equipment incorporating safety goals
- Suggest new techniques for device management

Unit I - Reliability and Safety Testing: Reliability – Types of reliability – Reliability optimization & assurance – Reliability's effect on medical devices – The concept of failure – Causes of failure – Types of Failures in Medical devices – Safety testing – Device specific safety goals, Failure assessment and Documentation – Visual inspection: External & Internal visual inspection – Measurement – Safety parameters, Function test

Unit II - Risk Management: Safety and risk management – Risk, Deciding on acceptable risk, Factors important to medical device risk assessment – Risk management – Tools for risk estimation – Liability – Manufacturer's and physician's responsibilities

Unit III - Medical Devices Handling, Environmental & Ecological Safety: Safe medical devices – Handling and operation – Medical Application safety – Usability – Clinical assessment – Environmental safety – Interference with the environment – Environmental conditions, Impact on the environment – Ecological safety

Unit IV - Mechanical and Electrical Safety: Safety Mechanics – Electrical Safety – Biological aspect – Limitation of Voltages - Macroshock and Microshock – Earth and Protection – Leakage currents – Magnetic fields and compatibility – Basic assumptions in safety technology – Safety classes

Unit V - Medical Devices Standards, Regulations & Directives: Medical Standards and Regulations – Device classification – Registration and listing – Declaration of conformance to a recognized standard – Investigational Device Exemptions (IDEs) – Institutional Review Boards (IRBs) – IDE format – Good laboratory practices (GLPs) – Good manufacturing practices (GMPs) – Human factors – Design control – The Medical Devices Directives (MDD) – Definition, Process and choosing the appropriate directive – Active Implantable Medical Devices Directive (AIMDD) – In Vitro Diagnostic Medical Devices Directive (IVDMDD).

Reference Books

1. Norbert Leitgeb "Safety of Electro-medical Devices Law – Risks – Opportunities" Springer Verlog/Wein, 2010.
2. Bertil Jacobson and Alan Murray, "Medical Devices Use and Safety", Elsevier Limited, 2007.
3. Richard Fries, "Reliable Design of Medical Devices – Second Edition", CRC Press, Taylor & Francis Group, 2006.
4. Gordon R Higson, "Medical Device Safety – The regulation of Medical Devices for Public Health and Safety", IOP Publishing Limited, Bristol and Philadelphia, 2002.
5. Shayne Cox Gad, "Safety Evaluation of Medical Devices" Second Edition, Marcel Dekker Inc., 2002.

17BM2027 ICU AND OPERATION THEATRE EQUIPMENT

Credit: 3:0:0

Course Objective:

- To offer clear understanding of various intensive care equipment and their working.
- To understand the necessity of different operation theatre equipment.
- To know about different dialyzers and ventilators.

Course Outcome:

- Apply the knowledge acquired, in designing new monitoring devices for ICU.
- Suggest suitable surgical instruments and operational devices.
- Assist the medical personnel's during emergency situations in the ICU.
- Compare the various techniques for clinical diagnosis, therapy and surgery, and its recent methods
- Assess the merits of the operation theatre equipment based on its applications
- Design the devices for the particular application based on given specifications.

Unit I - ICU Equipment: Suction apparatus, Different types; Sterilizers, Chemical, Radiation, Steam for small and larger units. Automated drug delivery systems, Infusion pumps, closed loop control infusion system, implantable infusion system.
Unit II - Critical Care Equipment: Hemodialysis Machine, Different types of Dialyzers, Membranes, Machine controls and measurements. Heart Lung Machine, different types of oxygenators, peristaltic pumps, Incubators.
Unit III - Operation Theatre Equipment: Surgical diathermy, Instruments for operation. Anesthesia Equipment, Humidification, Sterilization aspects, Boyles apparatus.
Unit IV - Centralised Systems: Centralized Oxygen, Nitrogen, Air supply & Suction. Centralized Air Conditioning, Operation Theatre table & Lighting.
Unit V - Patient Safety: Patient electrical safety, Types of hazards, Natural protective mechanisms against electricity, Leakage current, Inspection of grounding and patient isolation, Hazards in operation rooms, ICCU and IMCUs, Opto couplers and Pulse transformers.

Reference Books

1. Khandpur,R.S,"Handbook of Biomedical Instrumentation ",Second Edition. Tata Mc Graw Hill Pub. Co., Ltd. 2003
2. John, G. Webster. Medical Instrumentation, Application and Design. Second Edition. John Wiley & sons, Inc., NewYork. 2008.
3. Joseph Dubovy, Introduction to Biomedical.Mc Graw Hill Co.1978
4. Terry Bahil.A, Biomedical and Clinical Engineering. Prentice Hall Inc.1981

17BM2028 GRAPHICAL SYSTEM DESIGN FOR BIOMEDICAL ENGINEERS

Credits: 3:0:0

Course Objectives:

- To create knowledge in acquiring data and control an external measuring device by interfacing to a computer.
- To study about the basic of Programming Techniques and its applications.
- To become a performer in designing virtual instruments for various biomedical measurements and applications.

Course Outcomes:

- Understand Computer based instrumentation for real time applications
- Interfacing with real time signals
- Analyzing the application of VIs in medical instrumentation in developing medical instruments
- Perform signal processing operations using virtual instrumentation
- Identify salient traits of a virtual instrument and incorporate these traits in projects.
- Experiment, analyze and document in the laboratory prototype measurement systems using a computer, plug-in DAQ interfaces and bench level instruments.

Unit I - Labview programming principles & environment: Data flow – Definition, and importance of data flow in LabVIEW – Identify programming practices that enforce data flow in block diagram, Virtual instrumentation (VI), and sub-VIs - Identify programming practices that break data flow – Polymorphism - Define polymorphism - Identify benefits of polymorphism - Determine output or intermediate values of data elements in VI that utilizes polymorphic inputs LabVIEW Environment -Front panel window, block diagram, and connector pane - Identify which types of VIs do not have a block diagram - Identify the purpose of the connector pane and icon – Palettes

Unit II - Software constructs & programming functions: Front panel window and block diagram objects - Controls, indicators, IO controls, and refnums - Property Nodes - Data types and data structures - Working with objects and data types on front panel windows – Program control structures and data storage - Flat and Stacked sequence structures - Event structures- Formula Node - Arrays and clusters

Unit III - Data communication & synchronization: Local, global, and shared variables – Data Socket - TCP and UDP – Synchronization – Notifiers – Queues - VI Server - configuring the VI Server - Error handling VIs and functions - Debugging tools and techniques.

Unit IV - Virtual insturmentation (vi) design & subvi design techniques: Simple state machine - User interface event handler - Queued message handler - Producer/consumer (data) and producer/consumer (events) - Functional global variables - Connector panes and connection types - Polymorphic subVIs - Options related to subVIs - Error handling – User interface design and block diagram layout - Modular and hierarchical design - SubVI icons and connector pane layout (standard) - VI properties - Documenting VIs

Unit V - Memory, performance and determinism: Tools for identifying memory and performance issues - Profile memory and performance - Show buffer allocations- VI metrics - Programming practices - Enforcing dataflow -User interface updates and response to user interface controls - Data type selection, coercion, and buffer allocation - Array, string, and loop operations -Local and global variables, Property Nodes.

Reference Books

1. S. Sumathi, P.Surekha, "LabVIEW based Advanced Instrumentation Systems " springer 2007.
2. Gary Jonson, 'Labview Graphical Programming', McGraw Hill, New York, Fourth edition 2006.
3. Lisa K. wells & Jeffrey Travis, 'Labview for everyone', Prentice Hall Inc., First edition 1997.
4. S. Gupta, J.P: Gu.pta, 'PC interfacing for Data Acquisition & Process Control', Instrument Society of America, Second Edition, 1994

17BM2029 WEARABLE SYSTEMS AND DIGITAL HEALTH CARE

Credits: 3:0:0

Course Objectives:

- Understand the needs for wearable devices and the technology
- Learn the concepts in digital health care and digital hospitals
- Apply the tools in design, testing and developing digital health care equipment

Course Outcomes:

- Identify the available technology for wearable devices
- Interpret the need for digital methods of handling medical records
- Construct the tools and methods for work flow
- Compare various standards for inter-operability of devices
- Decide quality and safety standards for developing new devices
- Formulate advanced strategies for innovation to societal needs.

Unit I - Wearable devices and m-Health care: Introduction to mobile health care-devices-economy-average length of stay in hospital, outpatient care, health care costs, mobile phones, 4G, smart devices, wearable devices, Uptake of e-health and m-health technologies. Standards.

Unit II - Digital Radiology: Digital radiology for digital hospital, picture archiving and communication, system integration, digital history of radiology, medical image archives, storage and networks.

Unit III - e-Health: Health care networking, Medical reporting using speech recognition, physiological tests and functional diagnosis with digital methods, tele-consultation in medicine and radiology. Multimodality registration in daily clinical practice. Mobile health care.

Unit IV - Digital Health: Requirements and best practices, Laws and regulations in Digital health, Ethical issues, barriers and strategies for innovation.
Unit V - Standards for inter operability: Selection and Implementation in e-Health project, design of medical equipments based on user needs. Security and privacy in digital health care.

Reference Books

1. Wlater Hruby, " Digital revolution in radiology – Bridging the future of health care, second edition, Springer, New York. 2006.
2. Christoph Thuemmler, Chunxue Bai, "Health 4.0: How Virtualization and Big Data are Revolutionizing Healthcare", Springer, 1st ed. 2017.
3. Samuel A. Fricker, Christoph Thümmler , Anastasius Gavras, "Requirements Engineering for Digital Health", Springer 2015th Edition**.**
4. Rick Krohn (Editor), David Metcalf, Patricia Salber, "Health-e Everything: Wearables and the Internet of Things for Health, Part One: Wearables for Healthcare", HIMSS resources.ebook.

17BM2030 BIO-MEMS TECHNOLOGY

Credits: 3:0:0

Course Objective:

- Introduce the concepts of micro electromechanical systems in medical use
- Learn the materials used and the micro manufacturing of devices
- Apply Microsystems and their applications in medical field

Course Outcome:

- Identify the micro fabrication methods
- Summarize the principles of sensors and actuators
- Use the software tools for designing and analysing the sensors
- Classify the performance to various sensors to its environment
- Recommend the suitable principles for specific conditions
- Create simple systems for medical applications

Unit I - MEMS and Microsystem: Introduction, working principles, materials, micro machining.
Unit II - Micro sensor and actuator: Working principles of Beam, cantilever, piezoelectric sensor, thermal sensor, and actuator, Peltier heat pump and magnetic sensor.
Unit III - Micro Optical sensors: principles of micro lens, digital micro mirror, light detector, medical applications.
Unit IV - Micro fluidics: Fluid actuation methods, micro fluid dispenser, micro needle, micro pump.
Unit V - MEMS Biomedical applications: Micro TAS, micro pressure sensor for detecting human blood pressure, micro flow sensor, micro accelerometer, micro gyro. Radio pill micro device, biochip.

Reference Books

1. Tai Ran Tsu, "MEMS and Micro system design and manufacture", Tata McGraw Hill, New Delhi, 2002.
2. N.P.Mahalik, "Micro manufacturing & Nanotechnology", Springer, 2006.
3. SergeyEdwardLysherski.NanoandMicro-electromechanicalsystems.Second Edition.CRCPress.2005.
4. Wanjun Wang, Steven A. Soper, "BioMEMS Technologies and Applications", CRC Press. 2006.
5. Abraham P. Lee, James L. Lee, "BioMEMS and Biomedical Nano technology", Vol.I, Springer, 2006.

17BM3001 ADVANCED MEDICAL INSTRUMENTATION

Credits: 3:0:0

Course Objectives:

- Understand the fundamentals of human physiology system and its functions.
- Learn the fundamental concepts of physiological parameters measurement.
- Apply the concepts of various medical instruments for biomedical applications.

Course Outcomes:

- Identify the basic need of various human physiology system
- Demonstrate an interfacing circuit for real time bio signal acquisition and processing
- Construct the suitable acquisition method for analyzing biomedical signal.
- Categorize the real time system models for biomedical applications
- Evaluate the various structure for patient safety
- Design real time biomedical system for diagnosing various diseases

Unit I - Introduction to Human Physiology: Circulatory system – cardio vascular system-central nervous system – respiratory system – muscular skeletal system – digestive system – excretory system – sensory organs – voluntary and involuntary action.
Unit II - Biopotentials and their Measurements: cell and its structure – resting potentials – action potentials – bioelectric potentials – measurement of potentials and their recording – basic principles of ECG, EEG, EMG– Electrode theory – bipolar and Unipolar electrode-surface electrode – electrode impedance –equivalent circuit for extra cellular electrodes- micro electrodes.
Unit III - Computer based medical instrumentation: Computerised versions of ECG, EEG, EMG, Tread Mill Test ECG– Foetal monitor, cardiac arrthymias and its monitoring through Hotler monitor, Event monitors, Bispectral Index EEG for depth of anesthesia monitoring.
Unit IV - Operation theatre equipment and Critical Care instrumentation: Patient monitors, pulse oximetry, ICU ventilators, suction apparatus, anesthesia equipment, electro surgery, operating microscopes, motorized operation table, infusion pumps and syringe pumps, nerve stimulator, defibrillators, Electrical Safety and other safety aspects of medical equipment.
Unit V - Medical Imaging Techniques and Therapeutic, diagnostic equipment: X-rays – scanning techniques-ultrasound scanner- color Doppler system, CT, MRI scanning techniques – coronary angiogram, nuclear imaging, Specialized Therapeutic and diagnostic equipment Cardiac pacemakers, heart lung machines, haemodialysis, clinical laboratory instrumentation, Audiometer, Phonocardiogram.

Reference Books:

1. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2009.
2. Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi, 2007.
3. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 2003.
4. Myer Kutz , "Standard Handbook of Biomedical Engineering & Design", McGraw Hill Publisher, UK, 2003.

17BM3002 MEDICAL IMAGE COMPUTING

Credits: 3:0:0

Course Objectives:
- Learn the fundamentals of digital image processing
- Understand various methods of medical image processing techniques
- Apply the methodologies for clinical applications

Course Outcomes:
- Describe various concepts of digital image processing
- Select suitable technique for accomplishing specific image processing task
- Illustrate the steps involved in processing digital images
- Analyze the performance of image processing techniques
- Devise new ideas or tools to solve common issues in certain applications
- Assess the impact of digital image processing for medical application

Unit I - Image representation: Pixels and voxel**s,** gray scale and color representation, image file formats, DICOM, other formats- intensity transform functions, and the dynamic range, windowing, histogram and histogram operations, dithering and depth, filtering and fourier transform.
Unit II - Segmentation: The segmentation problem, Region of interest and centroid, theresholding, region growing, sophisticated segmentation methods, morphological operations, evaluation of segmentation results-Clinical applications.

Unit III - Spatial Transforms: Discretisation**,** interpolation and volume regularization, translation and rotation, reformatting, tracking and image guided therapy- Visualization, orthogonal and perspective projection, and their view point, raycasting, surface based rendering-Clinical applications.
Unit IV - Registration: Fusing information, registration paradigm, merit functions, optimization strategies-camera calibration, registration to physical space-evaluation of registration results- Clinical applications.
Unit V - CT reconstruction: Introduction-Radon transform-algebraic reconstruction-Fourier transform and filtering-filtered back projection-Clinical applications.

Reference Books

1. Wolfgang Birkfellner, "Applied medical Image Processing- A basic course", second edition, CRC Press, 2014.
2. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using Matlab", Third Edition Tata McGraw Hill Pvt. Ltd., 2011.
3. Anil Jain K. "Fundamentals of Digital Image Processing", PHI Learning Pvt. Ltd., 2011.
4. William K. Pratt, "Introduction to Digital Image Processing", CRC Press, 2013.
5. Chris Solomon, Toby Breckon, "Fundamentals of Digital Image Processing – A practical approach with examples in Matlab", Wiley-Blackwell, 2010.
6. Jayaraman, "Digital Image Processing", Tata McGraw Hill Education, 2011.
7. Malay K. Pakhira, "Digital Image Processing and Pattern Recognition", First Edition, PHI Learning Pvt. Ltd., 2011.

17BM3003 SOFT COMPUTING TECHNIQUES FOR BIOMEDICAL ENGINEERS

Credits: 3:0:0

Course Objectives:

- Introduce the basic concepts of neural networks and medical applications
- Learn fuzzy logic concept and its applications in biomedicine.
- Apply genetic algorithm, ant colony optimization and particle swam optimization techniques in solving medical engineering problems.

Course Outcomes:

- Identify the basics of machine learning algorithms.
- Demonstrate the application of soft computing.
- Apply the machine learning techniques to solve real world problems, mainly pertaining to medical applications.
- Design new algorithms through cognitive research.
- Develop new hypothesis based on the cognitive technology.
- Evaluate the effectiveness of the algorithms and modify.

Unit I - Introduction to neural networks: Introduction – Biological neurons and their artificial models – Learning, Adaptation and neural network's learning rules – Types of neural networks – Single layer, Multiple layer – Feed forward, Feedback networks, Back propagation– Learning and training.
Unit II - Special networks and applications: Associative memory – BAM – Hopfield network – ART Network – SOM – Case studies: Depth of anesthesia monitoring using neural networks, Bio signal classification, Pattern recognition.
Unit III - Introduction to fuzzy logic: Fuzzy sets – Fuzzy operation – Fuzzy arithmetic – Fuzzy relations – Fuzzy relational equations – Fuzzy measure – Fuzzy functions –Approximate reasoning – Fuzzy propositions –Fuzzy quantifiers – If then rules.
Unit IV - Fuzzy logic control: Structure of fuzzy logic controller – Fuzzification models –Data base – Rule base – Inference engine – Defuzzification module Case studies: Blood pressure monitoring during anesthesia using fuzzy logic, Image processing using fuzzy logic, Home heating system.
Unit V - Soft Computing Techniques and its applications: Fundamentals of genetic algorithm: Evolutionary computation – Search space – Encoding – Reproduction – Elements of genetic algorithm – Ant Colony Optimization techniques, Particle Swam Optimization techniques and its applications, Machine learning Algorithms – Random Forest, ANFIS, Case studies.

Reference Books:

1. Klir G.J. &Folger T.A. 'Fuzzy sets, uncertainty and Information', Prentice –Hall of India Pvt. Ltd.,1993.
2. Zimmerman H.J. 'Fuzzy set theory – and its Applications' – Kluwer Academic Publishers,1994.
3. Kosko, B. 'Neural Networks and Fuzzy Systems', Prentice – Hall of India Pvt. Ltd.,1994.
4. Jacek M Zurada, 'Introduction to Artificial Neural Systems', Jaico Publishing House, 1999.

17BM3004 MEDICAL SENSORS AND MEMS TECHNOLOGY

Credits: 3:0:0

Course Objectives:

- Understand the in depth and quantitative view of medical sensors, its characteristics and applications for wearable and smart sensors
- Overview of the current state of the art to micro sensor fabrication methods micro sensor design, analysis, materials and testing
- Apply the tools to design and development of sensors for the medical applications

Course Outcome:

- Identify the principle of medical sensors and its interfacing circuits for application
- Classify the micro sensor materials and fabrication process
- Apply the design tools to test and develop products to required specifications
- Analyze the most relevant challenges facing the smart sensor research field
- Evaluate a sensor based on standard performance criteria and appropriateness for an application and its impact on environment and user.
- Create the wearable sensor and micro sensor for the particular application,

Unit I - Classification of Medical Sensors: Sensors for Pressure Measurement- Sensors for Motion and Force Measurement- Sensors for Flow Measurement -Temperature Measurement- Sensors for speed, torque, vibration- Wearable Sensors-smart sensors.

Unit II - Introduction to MEMS And Microsystems: Working principle of Microsystems, materials for MEMS and Microsystems, micromachining, System modeling.

Unit III - Fabrication Methods: Properties of materials, Clean room, Fabrication methods, Lithography, epitaxy, sputtering, LIGA.

Unit IV - Microsensors And Acuators: Mechanical sensors and actuators – beam and cantilever, piezoelectric materials, thermal sensors and actuators- micromachined thermocouple probe, Peltier effect, heat pumps, thermal flow sensors, micro gripper microlens, microneedle, micropumps-Testing of the performance using LabVIEW.

Unit V - Design Of Micro System& Software Tools: Modeling and design, using Matlab, Design of sensors, pressure sensor, vibration sensor, actuators Analysis using solvers, Matlab, Intellisuite, mechanical solver, electrical solver.

References

1. Tatsuo Togawa, Toshiyo Tamura, P. Ake Oberg, "Bio-Medical Transducers and Instruments", CRC Press, USA, 2010.
2. Subhas Chandra Mukhopadhyay, Aime Lay Ekuakille, "Advances in biomedical sensing and measurements", Lecture notes in electrical engineering, Springer Verlag, Berlin,
3. Gabor Harsanyi, "Sensors in biomedical applications: fundamentals, technology & applications", CRC Press, USA, 2000.
4. Joseph D. Bronzino, "The biomedical engineering handbook", Volume 2, CRC Press, USA, 2000.
4. Tai Ran Hsu, "MEMS and Microsystems design and manufacture", Tata McGraw Hill Publishing Company, New Delhi, 2002
5. Wanjun Wang, Stephen A.Soper, "BioMEMs: Technologies and applications", CRC Press, New York, 2007.
6. Marc J. Madou 'Fundamentals of micro fabrication: the science of miniaturization', CRC Press, 2002.
7. Nadim Maluf, Kirt Williams. "An introduction to Micro electro mechancial Systems Engineering", Second Edition, Artech House Inc, MA, 2004.

17BM3005 MODELING AND IDENTIFICATION OF PHYSIOLOGICAL SYSTEMS

Credits: 3:0:0

Course Objectives:

- Understand basic ideas related to modeling the physiological system
- Learn the functions of various physiological systems and their characteristics
- Apply the tools to create and analyze the models

Course Outcomes:

- Analyze the concepts of modeling
- Differentiate the dynamics of circulatory system
- Perform the modeling for thermal regulatory system
- Design the model for Renal system
- Evaluate the mass-balance concept for respiratory system
- Identify the model of any Physiological system

Unit I - Basics of Physiological Systems: Systems Analysis, examples of physiological control systems, differences between engineering and physiological control systems. Generalized system properties, mathematical approach, electrical analogs, linear models, lung mechanics, muscle mechanics, distributed parameter versus lumped parameter models, static analysis, electrical model of neural control mechanism.

Unit II - Circulatory and Thermal Regulatory System: Physical, chemical and rheological properties of blood, problems associated with extra corporeal blood flow, dynamics of circulatory system. Parameters involved, Control system model etc. Biochemistry of digestion, types of heat loss from body, models of heat transfer between subsystem of human body like skin core, etc. and systems like within body, body, environment, etc.

Unit III - Ultra Filtration System: Transport through cells and tubules, diffusion, facilitated diffusion and active transport, methods of waste removal, counter current model of urine formation in nephron, Modeling Henle's loop.

Unit IV - Respiratory Systems: Modeling oxygen uptake by RBC and pulmonary capillaries, Mass balancing by lungs, Gas transport mechanisms of lungs, oxygen and carbon dioxide transport in blood and tissues.

Unit V - Identification of Physiological Systems: Non Parametric and parametric identification methods-Numerical Deconvolution, Least Squares Estimation-Correlation functions-frequency domain-optimization techniques, Identification of closed loop systems-case studies.

Reference books:

1. Michael C.K.Khoo, "Physiological control systems", Prentice hall India, 2000.
2. Johnenderly, Susanblanchard, Joseph bronzino. (2005), "Introduction to biomedical
3. Engineering", Second Edition, Academic press series in biomedical engineering.
4. David O Cooney, "Biomedical engineering principles", Marcel decker pub.Co., 2000.

17BM3006 REHABILITATION ENGINEERING

Credits: 3:0:0

Course Objectives:

- To know about various types of assist devices and its applications
- To understand the sensor and actuators and its integration for human assist devices for the disabled subjects
- To develop rehabilitation robots, mobility aids, assist devices for old aged

Course Outcomes:

- Describe the basic terminology in rehabilitation and models for societal applications
- Classify the sensors and actuators for particular applications.
- Discover the new methodology, products and systems for societal needs
- Analyze the performance of devices in various environmental conditions, design aspects
- Evaluate the design, performance, cost and affordability
- Develop the products based on cost effectiveness, user needs, environment friendly

Unit I - Introduction to rehabilitation-terminology, Health, disability, assist device, Assist device models, Safety standards, Community based rehabilitation.
Unit II - Sensors for rehabilitation-linear displacement, Angular displacement, velocity Strain, Force measurement, Motion sensor-accelerometer, Proximity sensor, optical encoder Electrical actuators for rehabilitation, electromechanical mechanism, Pneumatic actuators, Hydraulic actuators.
Unit III - Robots in rehabilitation- Robots in physiotherapy –Rehabilitation of the lower extremity, Robot assisted Gait training –measurements- evaluation.
Unit IV - Mobility aids: wheel chairs – types –wheel chair design, Design of caster-Smart wheel chair, Gyro based wheel chair with integrated controls, Personal and patient transportation system
Unit V - Assistive technology for daily living: Mobility and navigation, Accessible environments, GPS, Text based devices.

References

1. Volker Dietz, Tobias Nef, William Zev Rymer, "Neuro Rehabilitation technology", Springer Verilag, London, 2012.
2. Marion A. Hersh , "Assistive Technology for Visually Impaired and Blind People", CRC Press, 2005.
3. Letha. Y. Griffin, "Rehabilitation of the injured knee", Library of congress cataloging, USA, 1994.
4. Joseph D. Bronzino, "The Biomedical engineering handbook", Vol I, CRC press, 2000.

17BM3007 MEDICAL ETHICS

Credit: 3:0:0

Course Objective:

- Achieve familiarity with some basic ethical framework & understand how these ethical frame works can help us to think through contemporary questions in medical ethics.
- To know about the legal and ethical principles and application of these in medical field.
- Gain knowledge about the medical standards that to be followed in hospitals.

Course Outcomes:

- Identify the fundamental responsibilities of a clinical engineer.
- Develop a life style with ethical values and moral principles.
- Apply the moral values and ethics in their work environment
- Maintain the confidentiality issues in medical practice.
- Suggest standards that are patient centered.
- Evaluate the effect of safety standards.

Unit I - Introduction to medical ethics: Definition of Medical ethics, Scope of ethics in medicine, American medical Association code of ethics, CMA code of ethics- Fundamental Responsibilities, The Doctor and the Patient, The Doctor and the Profession, Professional Independence, The Doctor and Society.
Unit II - Ethical theories & moral principles: Theories-Deontology& Utilitarianism, Casuist theory, Virtue theory, The Right Theory. Principles - Non-Maleficence, Beneficence, Autonomy, Veracity, Justice. Autonomy & Confidentiality issues in medical practice, Ethical Issues in biomedical research, Bioethical issues in Human Genetics & Reproductive Medicine.
Unit III - Hospital accreditation: Accreditation- JCI Accreditation & its Policies. JCA accreditation, FDA regulations, Patient centered standards, Healthcare Organization management standards, NFPA standards, IRPC standards.
Unit IV - Ethics in Hospital safety: Life Safety Standards- Protecting Occupants, Protecting the Hospital From Fire, Smoke, and Heat, Protecting Individuals From Fire and Smoke, Providing and Maintaining Fire Alarm Systems, Systems for Extinguishing Fires Environment of Care Standards-Minimizing EC Risks, Smoking Prohibitions, Managing Hazardous Material and Waste, Maintaining Fire Safety Equipment, Features, Testing, Maintaining, and Inspecting Medical Equipment.
Unit V - Medical Application safety: Environmental safety, Interference with the environment, Ecological safety. Electrical Safety, Limitation of Voltages, Macroshock and Microshock- Earth and Protection, Leakage currents, Magnetic fields and compatibility. Medical Standards and Regulations.

Reference Books

1. Biomedical Ethics: A Canadian Focus. Johnna Fisher (ed.), Oxford University Press Canada. 2009
2. Robert M Veatch, "Basics of Bio Ethics", Second Edition. Prentice- Hall, Inc. 2003
3. Domiel A Vallero, "Biomedical Ethics for Engineers", Elsevier Pub.1st edition, 2007

17BM3008 EMBEDDED SYSTEM AND IoT IN HEALTH CARE

Credits 3:0:0

Course objectives:

- To learn about the Embedded Processors with Real World applications.
- To introduce the concept of biomedical applications in embedded systems.
- To enhance the knowledge in interfacing processes with embedded controllers.

Course outcomes:

- Outline the features of ATmega processor
- Design a biomedical application in an embedded processor.
- Identify IDE for embedded processor
- Write embedded c programming for real time applications
- Compare the features of ATmega processor with other processor
- Specify, analyze and develop prototype using IOT

Unit I - Internet concepts and infrastructure: Broad Band Transmission facilities –Open Interconnection standards –Local Area Networks – Wide Area Networks –Network management – Network Security – Cluster computers. Internet concepts - Capabilities and limitations of the internet -– Interfacing Internet server applications to corporate databases HTML and XML Web page design through programming and the use of active components.
Unit II - Design methodology and protocols: Introduction-Characteristics-Physical design - Protocols – Logical design – Enabling technologies – IoT Levels – Domain Specific IoTs – IoT vs M2M. IOT design methodology -IoT systems management – IoT Design Methodology – Specifications Integration and Application Development.
Unit III - Embedded systems: Generic Embedded Systems Structure- Components of Embedded Systems- Sensors and Actuators-importance of Analog/Digital Conversion- Embedded system based physiological monitoring system- Health care innovations using embedded system
Unit IV - Digital Health: Evolution of digital health-social Technological alignment – laws and regulations for digital health- ethical issues.
Unit V - IOT in health care: IOT based health care- physiological parameter monitoring system- future challenges in health care- health care echo system with IOT- IOT for personalized health care- wearable device characteristics-analysis of power aware protocols and standards for critical e-health applications social network analysis in health care embedded health care system for senior resident using IOT.

Reference:

1. Eugene C. Nelson, Paul B. Batalden, Marjorie M. Godfrey Quality By Design: A Clinical Microsystems Approach John wiley & sons 2007
2. Samuel A. Fricker, Christoph Thuemmler, Anastasius Gavras Requirements Engineering Dor Digital Health springer 2015.
3. Klaus Pohl, Harald Hönninger, Reinhold Achatz, Manfred Broy, "Model-Based Engineering Of Embedded Systems: The SPES 2020 Methodology, Springer, 2012.

17BM3009 DIAGNOSTIC AND THERAPEUTIC LABORATORY

Credits: 0:0:2

Course Objectives:

- To acquire, record and analyze the bio signals
- To study the different preamplifiers used for amplifying the bio signals.
- To impart knowledge about the equipment for diagnosis, therapy and surgical tools

Course Outcomes:

- Identify various sterilization methods in hospitals, equipments for post operative care units, operation theatre and physiotherapy.

- Identify the suitability of diagnostic and therapeutic equipment for specific applications.
- Analyze the performance of various biomedical equipments and their specifications.
- Apply appropriate measurement standards and safe handling of equipments in operation theatre, and surgical equipments
- Design the signal conditioning circuits and develop systems.
- Evaluate the performance of medical instruments.

Description:
This laboratory introduces the different diagnostic and therapeutic equipment, their working principles and the methodologies used for analysing and recording biosignal.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HOD/Director and notify it at the beginning of each semester.

17BM3010 MEDICAL SENSORS, INTERFACING & MEMS LAB

Credits: 0:0:2

Course Objectives:
- To acquire, record and analyse the IC type sensors, MEMS sensors,
- To study the different design tools software for analyzing and comparision.
- To impart knowledge about the equipments for MEMS fabrication methods

Course Outcomes:
- Acquisition, recording and analyse the IC type sensors, MEMS sensors.
- Identify the suitability interfacing circuits for applications.
- Analyze the performance of sensors in simulation tools
- Apply appropriate design standards and constrains
- Design the new sensors test the performance using LabVIEW.
- Evaluate the performance fabrication methods and 3D printing facility.

Description:
This laboratory introduces the different MEMS sensors their conditioning circuits, familiarize MEMS software tools, working and the methodologies used for fabrication of micro devices and 3D printing.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HOD/Director and notify it at the beginning of each semester.

17BM3011 EMBEDDED SYSTEM AND IoT LABORATORY

Credits: 0:0:2

Course Objectives:
- Understand the fundamental concepts in embedded system and design methodology
- Learn the fundamentals of Internet concepts and its applications
- Apply embedded and IoT concepts in health care applications.

Course outcomes:
- Acquire the knowledge and concepts of embedded system.
- Comprehends the challenges in system design
- Apply the concepts of embedded system for health care applications.
- Analyze the functions of digital health.
- Compare Various levels of IoT
- Evaluate future challenges in health care

Description:
This laboratory introduces the fundamentals of embedded based system development, familiarize software tools, design of IoT based applications in health care.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HOD/Director and notify it at the beginning of each semester.

17BM3012 AMBULATORY SERVICES

Credits 3:0:0

Course Objectives:

- Understand the fundamentals of patient monitoring system
- Learn the design of ambulance and transportation systems
- Apply computer based technology in ambulatory services

Course outcomes:

- Identify the principle of patient monitors and its interfacing circuits for application
- Classify the types of services and systems
- Apply the design tools to test and develop lift mechanism for given specifications
- Analyze the most relevant challenges facing the patient safety and protection
- Evaluate the systems based on the criteria and its impact on environment and user.
- Create the smart safety alert systems for the application

Unit I - Patient monitoring systems- artifacts-denoising techniques- Advancements in Wireless patient Monitoring system- Case study.
Unit II - Design of ambulance- Vehicle design- ambulance train- disaster relief squad- regulation for patient transportation- Case study.
Unit III - Lift mechanism- Design of lift mechanism for patient-design of lift in ambulance- computer based systems- Case study.
Unit IV - Design of mobile diagnostic equipment: devices with battery backup- mobile X-ray unit- nursing-medical gas handling-regulations-GPS in ambulance networked services- Case study.
Unit V - Accident care systems- automated alert system- smart safety systems-fire protection –maintenance and regulation-Accreditation for ambulance services- Case study.

Reference Books

1. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2005.
2. Andreas F. Molisch, "Wireless Communications, 2nd Edition, John Wiley & sons, USA, 2010.
3. Jochen Schiller, "Mobile Communications", Addison Wesley Publishers, 2000.
4. Yi-Bing Lin and ImrichChlamtac, "Wireless and Mobile Network Architecture", John Wiley and Sons, New Delhi, 2nd Edition, 2001.
5. Feher K., "Wireless Digital Communications", Prentice Hall of India, New Delhi, 1995.

17BM3013 TELEHEALTH TECHNOLOGY

Credits 3:0:0

Course Objectives:

- Understand the development of technology for support telehealth
- Learn the improved healthcare methods to meet greater expectations on the health service
- Apply the design, selection, procurement, installation, management, maintenance, and evaluation of telehealth systems appropriate to present and future needs.

Course Outcomes

- Identify the basics of telemedicine and its application
- Classify the technologies and standards
- Apply principles and methods of evaluation to telehealth projects
- Analyze the most relevant challenges in telemedicine to rural areas
- Evaluate the systems based on the criteria and its impact on environment and user.
- Create the telehealth technologies for future challenges in population

Unit I - Telemedicine And Health: History and Evolution of telemedicine, Functional diagram of telemedicine system, Telemedicine, Tele health, Tele care, Organs of telemedicine, Global and Indian scenario, Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Advances in Telemedicine.

Unit II - Telemedical Technology: Principles of Multimedia - Text, Audio, Video, data, Data communications and networks, PSTN, POTS, ANT, ISDN, Internet, Air/ wireless communications: GSM satellite, and Micro wave, Modulation techniques, Types of Antenna, Integration and operational issues, Communication infrastructure for telemedicine – LAN and WAN technology. Satellite communication. Mobile hand held devices and mobile communication. Internet technology and telemedicine using world wide web (www)-Video and audio conferencing-clinical data– local and centralized.

Unit III - Telemedical Standards: Data Security and Standards: Encryption, Cryptography, Mechanisms of encryption, phases of Encryption. Protocols: TCP/IP, ISO-OSI, Standards to followed DICOM,HL7, H. 320 series (Video phone based ISBN) T. 120, H.324 (Video phone basedPSTN), Video Conferencing, Real-time Telemedicine integrating doctors /Hospitals.

Unit IV - Mobile Telemedicine: Tele radiology: Definition, Basic parts of teleradiology system: Image Acquisition system Display system, Tele pathology, multimedia databases, color images of sufficient resolution, Dynamic range, spatial resolution, compression methods ,Interactive control of color.

Unit V - Telemedical Applications: Telemedicine access to health care services – health education and self care Introduction to robotics surgery, telesurgery. Telecardiology, Teleoncology, Telemedicine in neurosciences, Electronic Documentation, e-health services security and interoperability, Telemedicine access to health care services – health education and self

Reference Books

1. Norris, A.C, "Essentials of Telemedicine and Telecare", . Wiley (ISBN 0-471-53151- 0), 2002
2. Wootton, R., Craig, J., Patterson, V. (Eds.), "Introduction to Telemedicine", Royal Society of Medicine Press Ltd (ISBN 1853156779), 2006 .
3. O'Carroll, P.W., Yasnoff, W.A., Ward, E., Ripp, L.H., Martin, E.L. (Eds), "Public Health Informatics and Information Systems", Springer (ISBN 0-387-95474-0), 2003.
4. Ferrer-Roca, O., Sosa-Iudicissa, M. (editors), "Handbook of Telemedicine", IOS Press (Studies in Health Technology and Informatics, Volume 54). (ISBN 90- 5199-413-3), 2002.
5. Simpson, W. 2006. "Video over IP- A practical guide to technology and applications", Focal Press (Elsevier). ISBN-10: 0-240-80557-7.
6. Bemmel, J.H. van, Musen, M.A. (Eds.) (1997), "Handbook of Medical Informatics", Heidelberg, Germany: Springer. (ISBN 3-540-63351-0)

17BM3014 HOSPITAL AND EQUIPMENT MANAGEMENT

Credits 3:0:0

Course objectives:

- Understand the fundamentals of health care delivery services
- Learn the procedures in maintenance of equipments
- Apply the design principles in engineering systems

Course outcomes:

- Identify the principle of organizational structures and regulatory services
- Classify the types of codes followed and applications
- Apply the design to develop support systems
- Analyze the most challenges in environment and market trends
- Evaluate the systems based on the safety criteria to environment
- Create the methodology for new equipments to user needs

Unit I - Health And Hospital Management: Health organisation of the country, the State, the Cities and the Region, Management of Hospital Organisation, Nursing Sector, Medical Sector, Central Services, Technical Department, Definition and Practice of Management by Objective, Transactional Analysis Human Relation in Hospital, Importance of Team Work, Legal aspect in Hospital Management. Case study: Health survey.

Unit II - Regulatory Requirement And Health Care Codes: FDA Regulation, Joint Commission of Accreditation for Hospitals, National Fire Protection Association Standard, ISO, NABL, Environmental regulation. Case study on ISO.

Unit III - Equipment Maintenance Management: Hospital architecture, Piping, planning of construction, Organising, Maintenance Operations, Maintenance Job Planning, Maintenance Work Measurement and Standards,

Preventive Maintenance, Maintenance Budgeting and Forecasting, Maintenance Training, Contract Maintenance. Case study: Laboratory automation.

Unit IV - Clinical Engineering: Role to be performed in Hospital, Manpower & Market, Professional Registration, Maintenance of Hospital support system, surveillance network, electric power management, Medical gas production, waste disposal, inventory control. Case study: RF id tag for inventory.

Unit V - Hospital Equipments: Operation of safety devices, personnel safety equipments, Gas mask, Radiation measurements, equipment safety systems, elements of basic first aid, fire fighting, Case study: Safety Awareness.

REFERENCES

1. Cesar A.Caceres and Albert Zara, "The Practice of Clinical Engineering, Academic Press, New York, 1977.
2. Webster.J.G. and Albert M.Cook, "Clinical Engineering Principles and Practices Prentice Hall Inc., Englewood Cliffs, New Jersey, 1979.
3. Hans Pfeiff, Vera Dammann (Ed.), "Hospital Engineering in Developing Countries", Report, Eschbom,1986
4. Jacob Kline, Handbook of Bio Medical Engineering, Academic Press Inc.San Deigo,1988
5. R.C.Goyal, "Human Resource Management in Hospital", Prentice Hall of India, 3rd edition, 2000.
6. Syed Amin Tabish "Hospital and Health services Administration Principles and Practices" Oxford Press, New Delhi, 2001.

17BM3015 ROBOTICS IN SURGERY

Credits: 3:0:0

Course objectives:

- Understand the fundamentals of robotics and its degree of freedom
- Learn the various sensor and actuators required for its functions
- Apply the machine learning concepts in medical applications

Course outcomes:

- Identify the fundamental concepts in robotic systems
- Classify the types of sensors and actuators for its applications
- Apply the design tools to develop artificial intelligence techniques
- Analyze the conditions required for testing and control of autonomous robots
- Evaluate the safety aspects to human and environment
- Create the robots for assisting in surgery

Unit I - Introduction to Robotics, degree of freedom, path planning, Lagrange equation of motion, kinetics, payload, Links and Joints,

Unit II - Sensors and actuators: gripper- tactile sensor, Sensor for vision and motion, proximity switches, controllers. Path planning, path tracking, GPS based feedback control.

Unit III - Programmable controller, artificial intelligence, machine vision, design of controllers based on embedded system, human machine interface, case studies

Unit IV - Human-robot interaction, human factors: perception, motor skills, social aspect of interaction, safety, Haptic robots, collision detection, autonomous robots. Applications in physiotherapy.

Unit V - Robotics in surgery: surgical robotics, robot supported diagnostics, micro-robots, nanorobots at the cell level, Robots in medical applications.

Reference Books

1. Jacob Rosen, Blake Hannaford, Richard.M.Satava, "Surgical Robotics", Systems Applications and Visions", Springer, 2011.
2. Farid Gharagozloo, Farzad Najam, "Robotic surgery", McGraw Hill Publishers, US, 2009.First edition.
3. Bruno Siciliano and Lorenzo Sciavicco, "Robotics: Modeling, Planning and Control", Springer, 2010.
4. Bruno Siciliano, Oussama Khatib, "Springer Handbook of Robotics", Springer, 2008.
5. M. Tavakoli, R.V. Patel, M. Moallem, A. Aziminejad, Haptics for Teleoperated Surgical Robotic Systems, World Scientific, 2008
6. Jose L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons, 2008.

7. V. Dietz, T. Nef, W.Z. Rymer, "Neurorehabilitation Technology", Springer, 2012
8. E. Burdet, D.W. Franklin, T.E. Milner, "Human Robotics: Neuromechanics and Motor Control", The MIT Press, 2013.

17BM3016 SPEECH SIGNAL PROCESSING

Credits: 3:0:0

Course Objective:

- To introduce the models for speech production
- To develop time and frequency domain techniques for estimating speech parameters
- To introduce concepts of speech compression, recognition, synthesis and speaker identification

Course Outcome

- Qualitatively describe the mechanisms of human speech production.
- Analyse speech signals in the time and frequency domains
- Solve problems regarding parameter estimation in source-filter production models for speech analysis
- Devise methods and systems for efficient quantization and coding of speech signals, speech enhancement and simple pattern-recognition.
- Evaluate the methods used for speech signal analysis and apply suitable methods for practical applications.
- Deign an simple system for speech processing

Unit I - Nature of Speech Signal - Speech production mechanism, Classification of speech, sounds, nature of speech signal, models of speech production. Speech signal processing: purpose of speech processing, digital models for speech signal, Digital processing of speech signals, Significance, short time analysis.
Unit II - Time Domain Methods For Speech Processing - Time domain parameters of speech, methods for extracting the parameters, Zero crossings, Auto correlation function, pitch estimation.
Unit III - Frequency Domain Methods For Speech Processing - Short time Fourier analysis, filter bank analysis, spectrographic analysis, Format extraction, pitch extraction, Analysis - synthesis systems.
Unit IV - Linear Predictive Coding of Speech - Formulation of linear prediction problem in time domain, solution of normal equations, Interpretation of linear prediction in auto correlation and spectral domains.
Unit V - Homomorphic Speech Analysis - Central analysis of speech, format and pitch estimation, Applications of speech processing - Speech recognition, Speech synthesis and speaker verification.

References

1. Theory and Applications of Digital Speech Processing, Rabiner and Schafer, 2011
2. Speech and Audio Signal Processing , Gold and Morgan, Wiley and sons, 2011
3. Daniel Jurafsky & James H.Martin, "Speech and Language Processing", Pearson Education, 2000
4. Thomas F.Quatieri, "Discrete – Time Speech Signal Processing", Pearson Eduation, 2008.

17BM3017 HOSPITAL AUTOMATION

Credits: 3:0:0

Course Objectives

- To introduce the concepts of hospital systems and need for central monitoring
- To learn about power generation, utility and protection system
- To Apply distributed and central monitoring functions in hospital environment

Course outcomes:

- Identify the factors in central power generating and monitoring systems
- Classify the equipment types and its applications
- Apply software tools and digital computer for monitoring of parameters, Medical data handling
- Analyze the sensors and actuators for the automation systems
- Evaluate the methodologies in measurement systems and automation
- Create central monitoring station for hospitals for control and surveillance applications.

Unit I - Hospital system automation: power generator, maintenance, battery-maintenance and troubleshooting, energy conservation and monitoring system- Case study.

Unit II - Medical gas production: Automation in dryer, compressor, air conditioning, lighting, heating systems.
Unit III - Automation in piping: Monitoring of flow -Leakage test- prevention and safety automation.
Unit IV - Instrumentation systems: limit switches, sensors, controllers, control room, central monitoring station- alarm system –regulation and standards. Case study.
Unit V - Office Automation: Tools for data retrieval, RFID in medical record -surveillance system in hospital- case study.

Reference Books

1. Khandpur. R. S., "Handbook of Biomedical Instrumentation", Prentice Hall of India, New Delhi, 2003.
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education India, Delhi, 2008.
3. Curtis Johnson, D., "Process Control Instrumentation Technology", Prentice Hall of India, 2006.
4. John V. Grimaldi and Rollin H. Simonds., Safety Management, All India Travelers Book seller, New Delhi, 1989.
5. N.V. Krishnan, Safety in Industry, Jaico Publisher House, 1996.

17BM3018 HUMAN ASSIST DEVICES

Credits 3:0:0

Course Objective:

- Introduce the Fundamental terms and concepts of human assist devices
- Learn various assist device functions and characteristics.
- Apply design tools for modeling and analysis of assist devices

Course Outcomes:

- Identify the requirements for human assist devices
- Classify the systems based on applications
- Apply soft tools for analysis and design of devices for specific applications
- Analyze the merits of human assist system and its influence to environment.
- Evaluate the methodologies in measurement systems and conditions
- Create instrumentation techniques for development of assist devices to human needs

Unit I - Heart Lung Machine And Artificial Heart: Condition to be satisfied by the H/L System. Different types of Oxygenators, Pumps, Pulsatile and Continuous Types, Monitoring Process, Shunting, The Indication for Cardiac Transplant, Driving Mechanism, Blood Handling System, Functioning and different types of Artificial Heart, Mock test setup for assessing its Functions
Unit II - Cardiac Assist Devices: Synchronous Counter pulsation, Assisted through Respiration Right Ventricular Bypass Pump, Left Ventricular Bypass Pump, Open Chest and closed Chest type, Intra Aortic Balloon Pumping Veno Arterial Pumping, Prosthetic Cardio Valves, Principle and problem, Biomaterials for implantable purposes, its characteristics and testing. Case study.
Unit III - Artificial Kidney: Indication and Principle of Haemodialysis, Membrane, Dialysate, Different types of heamodialysers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type- Modeling and analysis. Case study.
Unit IV - Prosthetic And Orthodic Devices : Hand and Arm Replacement - Different Types of Models Externally Powered Limb Prosthesis Feedback in Orthodic System, Functional Electrical Stimulation, Haptic Devices
Unit V - Respiratory And Hearing Aids: Intermittent positive pressure, Breathing Apparatus Operating Sequence, Electronic IPPB unit with monitoring for all respiratory parameters. Types of Deafness, Hearing Aids- Construction and Functional Characteristics.

Reference Books

1. Kolff W.J., Artificial Organs, John Wiley and Sons, New York, 1979.
2. Andreas.F.Von racum, Hand book of bio material evalution, Mc-Millan publishers, 1980.
3. Albert M.Cook and Webster J.G., Therapeutic Medical Devices, Prentice Hall Inc., New Jersey, 1982
4. Gray E Wnek, Gray L Browlin – Encyclopedia of Biomaterials and Biomedical Engineering – Marcel Dekker Inc New York 2004.
5. John. G . Webster – Bioinstrumentation - John Wiley & Sons (Asia) Pvt Ltd, 2004.

17BM3019 HUMAN COMPUTER INTERFACES

Credits 3:0:0

Course objectives:

- Understand the fundamentals of EEG signal acquisition techniques
- Learn the feature extraction methods
- Apply the design principles in developing EEG based robotic application

Course outcomes:

- Identify the fundamental principles of EEG signal and data acquisition methods
- Classify the types of signals and its components
- Apply the design tools to develop simulation models
- Analyze the signals to develop the applications
- Evaluate the systems based on the design specifications
- Create the applications for medical diagnosis and robots

Unit I - Introduction To Brain Computer Interfaces: Concept of BCI – Invasive and Non-invasive Types – EEG Standards – Signal Features – Spectral Components – EEG Data Acquisition – Pre-processing – Hardware and Software – Artifacts – Methods to Remove – Near Infrared BCI.
Unit II - BCI Approaches: Mu Rhythm – Movement Related EEG Potentials – Mental States – Visual Evoked Potential Based – P300 component.
Unit III - EEG Feature Extraction Methods: Time/Space Methods – Fourier Transform – Wavelets – AR models – Band pass filtering – PCA – Laplacian Filters – Linear and Non-linear Features.
Unit IV - EEG Feature Translation Methods: LDA – Regression – Memory Based – Vector Quantization – Gaussian Mixture Modeling – Hidden Markov Modeling.
Unit V - Case Study: Case Study of Problems in BCI - Case Study of Brain Actuated Control of Mobile Robot.

Reference Books

1. Special Issue on Brain Control Interfaces, IEEE Transactions on Neural Systems and Rehabilitation Engineering, Vol 14, June 2006.
2. Andrew Webb, “Statistical Pattern Recognition”, Wiley International, Second Edition, 2002.
3. R.Spehlmann, “EEG Primer”, Elsevier Biomedical Press, 1981.
4. Arnon Kohen, “Biomedical Signal Processing”, Vol I and II, CRC Press Inc, Florida.
5. Bishop C.M, “Neural Networks for Pattern Recognition”, Oxford, Clarendon Press, 1995.
6. Torsten Felzer, “On the possibility of Developing a Brain Computer Interface”, Technical Report, Technical University of Darmstadt, Germany, 2001.
7. Wolpaw J.R, N.Birbaumer et al, “Brain control interface for Communication and control”, Clinical Neurophysiology, 113, 2002.
8. Jose del R.Millan et al, “Non-invasive brain actuated control of a mobile robot by human EEG”, IEEE Transactions on biomedical Engineering, Vol 51, No.6, 2004 June.

17BM3020 ERGONOMICS IN HOSPITALS

Credit 3:0:0

Course Objectives:

- Introduce the Fundamental terms and concepts of human factors
- Learn anthropometric principles and optimize human well-being and overall performance.
- Apply signal acquisition and processing of human stress related issues in hospital work area.

Course Outcomes:

- Identify the problems in posture and work efficiency
- Classify the workspace and related systems
- Apply signal processing techniques for analysis and feature extraction.
- Analyze the anthropometric concepts to human system and environment.
- Evaluate the methodologies in measurement systems and conditions
- Create instrumentation techniques for development of user friendly systems

Unit I - Human–machine system: Definition, human technological system, manual, mechanical, automated system, human system reliability, human system modeling, Human Output And Control, material handling, motor skill, human control of systems, controls and data entry devices, hand tools and devices,
Unit II - Workplace Design: Applied anthropometry, workspace design and seating, design of computer worktable, case studies.
Unit III - Measurement: physical stress and fatigue using EMG and EEG- Modeling of pain. Case study.
Unit IV - Environmental Conditions: Illumination, climate, noise, motion, sound, vibration. Musculoskeletal anatomy, Quantitative models, Case study
Unit V - Human body kinematics: Instrumentation concepts - Instrumentation for the Measurement human body kinematics. Case studies: computer based evaluation of recovery process caused due to limb fractures, cognitive stress to patients.

Reference Books

1. Bridger R S, "Introduction to Ergonomics", Taylor and Francis, London, 2003.
2. Karl Kroemer, Henrike Kroemer, Katrin Kroemer-Elbert, "Ergonomics- How to Design for Ease & Efficiency", Prentice Hall International Editions, 2001.
3. Mark S Sanders, "Human Factors in Engineering and Design", McGraw Hill, NewYork, 1993.
4. Martin Helander, "A Guide to Ergonomics of Manufacturing", Tata McGraw Hill, 1996.
5. Mccormic.E.J., and Sanders.M.S, "Human factors in Engineering and Design", McGraw Hill, New Delhi.

17BM3021 FINITE ELEMENT MODELLING IN BIOMEDICAL ENGINEERING

Credit 3:0:0

Course Objectives:

- Introduce the fundamentals of Finite Element Analysis
- Learn enable the students to formulate the design problems into FEA.
- Apply finite element technology to develop medical applications

Course Outcomes:

- Identify the fundamentals of concepts and FE tools
- Classify the methods for suitable applications
- Apply solver tools for analysis and design for specific applications
- Analyze the medial applications and its influence to environment.
- Evaluate the methodologies to optimize the design and analysis
- Create the medical applications to human needs

Unit I - Introduction: Basic concepts- Historical Background -finite element packages- Boundary Value and Initial Value Problem-Weighted Residual Methods-General Procedure of FEA-Element Types and its Characteristics.
Unit II - Concept of Element Assembly-Bandwidth and its effects- Boundary conditions-Aspect Ratio- Pascal's Triangle- Stiffness matrix -beam element-Shape Function for Spar element, Beam element- Convergence and Continuous criteria.
Unit III - Structural Problems: Equations of elasticity- plane elasticity problems - Bending of elastic plates Heat Transfer Problems.
Unit IV - One Dimensional equation: Heat transfer derivation of finite element equation -Fluid Mechanics problems: incompressible fluid flow-Biomedical Applications.
Unit V - Case studies: FE modeling of blood flow channel, limb, bone, implants, sensors analysis using mechanical solver, electrical solver, electro mechanical solver, Vibration analysis using software tools.

Reference Books

1. David.V.Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw Hill, 2003.
2. Tirupathi, R.Chandrupatla, Ashok. D.Belegundu, "Introduction to Finite Elements in Engineering", Prentice Hall of India, 2004.
3. Rao. S.S., "The Finite Element Method in Engineering", 2/e, Pergamon Press, Oxford, 2001.