SRM
UNIVERSITY
(Under section 3 of UGC Act 1956)

M.Tech. (Full Time) - Biomedical Engineering
Curriculum & Syllabus
2013 – 2014 (Revised)
With effect from 2015-16

FACULTY OF ENGINEERING AND TECHNOLOGY
SRM UNIVERSITY
SRM NAGAR, KATTANKULATHUR – 603 203

School of Bioengineering
Department of Biomedical Engineering

M.Tech Biomedical Engineering
Curriculum – 2013 – 14

(Applicable for students admitted from the academic year 2013-14 onwards)

COURSE CODE	COURSE NAME				
SEMESTER I		**L**	**T**	**P**	**C**
BM2001	ANATOMY AND PHYSIOLOGY	3	0	2	4
BM2002	ADVANCES IN BIOMEDICAL INSTRUMENTATION	3	0	2	4
BM2003	BIOMEDICAL SIGNAL ANALYSIS	3	0	2	4
BM21XX	PROGRAM ELECTIVE I	3	0	0	3
BM21XX	PROGRAM ELECTIVE II	3	0	0	3
SEMESTER II		**L**	**T**	**P**	**C**
BM2004	METHODS OF MEDICAL IMAGE ANALYSIS	3	0	2	4
BM2005	PHYSIOLOGICAL MODELING AND COMPUTATION	3	0	2	4
BM2006	BIOMECHANICS AND FINITE ELEMENT ANALYSIS	3	0	2	4
BM21XX	PROGRAM ELECTIVE III	3	0	0	3
BM21XX	PROGRAM ELECTIVE IV	3	0	0	3
SEMESTER III		**L**	**T**	**P**	**C**
BM21XX	PROGRAM ELECTIVE V	3	0	0	3
BM21XX	PROGRAM ELECTIVE VI	3	0	0	3
BM2048	INDUSTRIAL TRAINING (PASS / FAIL	0	0	1	1

	COURSE)				
BM2049	PROJECT WORK PHASE I	0	0	12	6
SEMESTER IV		**L**	**T**	**P**	**C**
BM2050	PROJECT WORK PHASE II	0	0	32	16
SEMESTER I-III					
MA2020	Applied Mathematics (supporting course of 3 credits in I, II or III sem.)	3	0	0	3
XXXXXX	INTERDISCIPLINARY ELECTIVE (1 course of 3 credits in I, II or III sem.)	3	0	0	3
TOTAL CREDITS TO BE EARNED FOR THE AWARD OF M.TECH DEGREE – 71					
	PROGRAM ELECTIVE COURSES	**L**	**T**	**P**	**C**
A) NATIONAL INSTRUMENTS CERTIFIED BIOMEDICAL ENGINEER					
BM2101	LABVIEW – GRAPHICAL SYSTEM DESIGN PLATFORM	3	0	0	3
BM2102	SYSTEM ANALYSIS TECHNIQUES	3	0	0	3
BM2103	INTELLIGENT INSTRUMENTATION	3	0	0	3
BM2104	MEDICAL ROBOTICS AND AUTOMATION	3	0	0	3
BM2105	NI LABVIEW CERTIFICATION: CERTIFIED LABVIEW EMBEDDED SYSTEMS DEVELOPER (CLED) – PART 1	3	0	0	3
BM2106	NI LABVIEW CERTIFICATION: CERTIFIED LABVIEW EMBEDDED SYSTEMS DEVELOPER (CLED) - PART 2	3	0	0	3
B) APPLICATION SPECIALIST IN RADIOLOGY					
BM2107	MEDICAL IMAGING USING X- RAYS	3	0	0	3

BM2108	SPECIALIZED X-RAY MEDICAL EQUIPMENTS	3	0	0	3
BM2109	COMPUTER ASSISTED TOMOGRAPHY IMAGING	3	0	0	3
BM2110	NUCLEAR MEDICINE	3	0	0	3
BM2111	ULTRASOUND MEDICAL IMAGING	3	0	0	3
BM2112	MAGNETIC RESONANCE IMAGING	3	0	0	3
C) SALES AND SERVICE BIOMEDICAL ENGINEER					
BM2113	DESIGN OF MEDICAL DEVICES	3	0	0	3
BM2114	THERAPEUTIC AND SURGICAL INSTRUMENTS	3	0	0	3
BM2115	BIOMEDICAL MICRO DEVICES	3	0	0	3
BM2116	BIOMEDICAL LASER TECHNOLOGY	3	0	0	3
BM2117	QUALITY CONTROL AND STANDARDS FOR BIOMEDICAL DEVICES	3	0	0	3
BM2118	TROUBLESHOOTING IN MEDICAL INSTRUMENTS	3	0	0	3
D) BIOMEDICAL ENTREPRENEUR					
BM2119	BASICS OF MEDICAL ELECTRONICS	3	0	0	3
BM2120	HEALTH CARE AND HOSPITAL MANAGEMENT	3	0	0	3
BM2121	INTRODUCTION TO MEDICAL PRODUCT REGULATION	3	0	0	3
BM2122	TELEMEDICINE AND E-HEALTH	3	0	0	3
BM2123	MEDICAL ETHICS	3	0	0	3
	one program elective from courses offered by faculty of management				
E) RESEARCH AND DEVELOPMENT BIOMEDICAL ENGINEER					
BM2124	BIOMATERIALS FOR THE DESIGN OF	3	0	0	3

	MEDICAL DEVICES				
BM2125	ADVANCES IN REHABILITATION ENGINEERING	3	0	0	3
BM2126	NEURAL ENGINEERING AND MODELING	3	0	0	3
BM2127	ERGONOMICS	3	0	0	3
BM2128	ADVANCED NEURAL NETWORKS AND GENETIC ALGORITHMS	3	0	0	3
BM2129	COMPUTATIONAL FLUID DYNAMICS IN MEDICINE	3	0	0	3

SEMESTER I

BM2001	ANATOMY AND PHYSIOLOGY	L	T	P	C
	Total Contact Hours - 75	3	0	2	4
	Prerequisite				
	Nil				

PURPOSE	
To provide good understanding of human anatomy and physiology which is basis of medicine	
INSTRUCTIONAL OBJECTIVES	
1.	To describes the form and organization of various anatomical structures and determines how they can functions
2.	To provide knowledge about systems and how they are dependent on each other to survive and operate the human body
3.	To give terms with precise meaning helps investigators to communicate effective

UNIT I - STUDY OF CELLULAR SYSTEM AND BLOOD COMPONENTS (9 hours)

Cell - Structure and organelles - Functions of each component in the cell- Cell membrane – Transport across membrane – origin of cell membrane potential - Nernst and Goldman and Katz equations – Action potential - Blood composition - functions of blood – functions of RBC, WBC, platelets - Blood flow factors-viscosity, radius, density Fahreuslindqvist effect, Poiseuille's Law.

UNIT II – CARDIOVASCULAR AND RESPIRATORY SYSTEMS (9 hours)

Heart – anatomy – cardiac cycle – ECG – Heart sounds – Blood vessels – anatomy – circulation types – Blood pressure – Regulation of BP - Respiratory system – parts – Mechanics of Respiration – transport of O_2 and Co_2 – Respiration regulation – Volume and lung capacities – Hypoxia – types.

UNIT III- MUSCULOSKELETAL AND NERVOUS SYSTEMS (9 hours)

Nerve cell – classification of nervous system – brain, spinal cord anatomy – hemispheres – CSF – meninges – reflexes – PNS – Skeleton – anatomy – structure of long bone - formation, growth and repair – joints – classification – muscles – types – sliding filament model – physiology of muscle contraction.

UNIT IV – DIGESTIVE AND EXCRETORY SYSTEMS (9 hours)

GI tract – movements – Digestion at various parts of the system – accessory organs of digestion – defecation – urinary system - Nephron – Microanatomy and functions – formations – micturition.

UNIT V– SPECIAL ORGANS AND ENDOCRINE SYSTEMS (9 hours)

Eye – retinal layers – visual path way – ear – physiology – auditory path way – series of taste smell – touch – temperature regulation – endocrine glands – hormones – secretions of pituitary, thyroid, parathyroid glands – maintenance of glucose and calcium homeostasis

REFERENCES

1. Elaine.N. Marieb, "*Essential of human Anatomy and Physiology"*, Pearson Education, New Delhi, Eight edition, 2007.
2. William F.Ganong, "*Review of Medical Physiology"*, 22nd edition, Tata Mc Graw Hill New Delhi, 2010.
3. A.K Jain, "*Text book of Physiology"*, volume I and II, Avichal Publishing Company, New Delhi, Third edition, 2005
4. Sarada Subramanyam, Madhavan Kutty K. and Singh H.D., "*Text Book of Human Physiology*" S.Chand and Company, 1996.
5. Arthur.C.Guyton, "*Textbook of Medical Physiology*" Prism Book (P) Ltd, 1996.
6. Ranganathan, T.S. "*Text Book of Human Anatomy*", S.Chand&Co. Ltd., Delhi, 1996.

Practical
(30 hours)

LIST OF EXPERIMENTS

1. To perform the hearing test using audiometer.
2. Eye muscle coordination testing
3. Bone density evaluation using Bone Densitometer
4. Acquisition of Electro Oculogram
5. Language of anatomy
   Landmarks, caritie
6. Organ system overview
7. Locate, Identify, name the parts and describe functions of the following using models / figures.
   - Different membrane

- Skin
- Bones joints and their types
- Muscle and their types
- Nerve cell
- Endocrine glands
- Heart, blood vessels
- Urinary system
- Respirator system
- Digestive system

8. Listening to heart sounds
9. Blood rate measurement change with posture
10. Pulse rate measurement
11. Measurement of vital capacity using spirometer
12. Visit to human anatomy and physiology laboratory in the medical college

REFERENCES

Anatomy and physiology laboratory manual

BM2002	**ADVANCES IN BIOMEDICAL INSTRUMENTATION**	**L**	**T**	**P**	**C**
	Total Contact Hours – 75	**3**	**0**	**2**	**4**
	Prerequisite				
	Nil				

PURPOSE	
The course is designed to make the student acquire an adequate knowledge about physiological parameter measurement and Physiological systems of the human body and the vital parameter measurements.	
INSTRUCTIONAL OBJECTIVES	
1.	To study about bio-electric signals and recording systems
2.	To introduce blood gas measurement principle

3.	To study about monitoring of vital parameters using patient monitoring system
4.	Learn about instruments used for special senses
5.	To provide latest knowledge on clinical diagnosis using bio-chemical tests

UNIT I - ELECTRO PHYSIOLOGICAL MEASUREMENTS (9 hours)

Electrodes –Limb electrodes –floating electrodes – pre-gelled disposable electrodes – Micro-, needle- electrodes – Amplifiers – Differential amplifiers, Instrumentation amplifier, Chopper amplifiers – Isolation amplifier. ECG, EEG, EMG - Lead systems and recording methods.

UNIT II - BLOOD GAS ANALYZERS AND OXIMETERS (9 hours)

Blood pH measurement- Blood pCO_2 measurement- Blood pO_2 measurement- intra arterial - complete blood gas analyzer – Oximetry - Principle, ear, pulse, skin reflectance, intravascular oximeter.

UNIT III- PATIENT MONITORING SYSTEMS (9 Hours)

Patient monitoring system-Bedside, Central monitoring, Measurement of heart rate, pulse rate, blood pressure-Direct-, and indirect- methods, temperature, respiration rate, catheterization laboratory instrumentation

UNIT IV - EAR AND OPTHALMOLOGICAL EQUIPMENTS (9 hours)

Ear: Hearing loss, Sound conduction system, Basic audiometer - Pure tone audiometer - Audiometer system-Bekesy - Evoked response audiometer system - Hearing aids. Vision: Visual acuity, Tonometer, Ophthalmoscope, Perimeter.

UNIT V – CLINICAL LAB INSTRUMENTS (9 hours)

Introduction-medical diagnosis with chemical test – Spectrophotometer – Colorimeter - Auto analyzers - clinical flame photometer - selective ion based electrolytes - Electrical safety in medical environment - shock hazards – leakage current-safety codes-electrical safety analyzer - testing of biomedical equipments.

REFERENCES

1. R. S. Khandpur "*Handbook of Bio-Medical Instrumentation*", 2nd Edition, Tata McGraw Hill, 2003.
2. Leslie Cromwell, Fred J Weibell, Erich A Pfeiffer "*Biomedical Instrumentation and Measurements"*, Prentice Hall of India, 2011
3. Joseph J. Carr and John M Brown, "*Introduction to Biomedical Equipment Technology*", 4 th edition, Pearson Education, 2008

4. John G.Webster (editor), "*Bioinstrumentation"*, John Wiley & Sons, 2004
5. Joseph Bronzino, "*Biomedical Engineering & Instrumentation"*, Taylor & Francis, 3rd edition, 2006.
6. Ronald Pitts Crick, Pang Khaw "*Text book of clinical Ophthalmology*", 2nd Edition, World
7. Scientific publication. ISBN 981-238-128-7

Practical
(30 hours)

LIST OF EXPERIMENTS

1. To design pulse oximeter.
2. To design and develop the physiological monitor module.
3. To design and acquire the real time ECG amplifier system.
4. To design the basic defibrillator module.
5. To study and demonstrate physiotherapeutic device.
6. To study and demonstrate surgical diathermy device.

REFERENCES

Advanced Biomedical Instrumentation Lab Manual

BM2003	**BIOMEDICAL SIGNAL ANALYSIS**	**L**	**T**	**P**	**C**
	Total Contact Hours - 75	**3**	**0**	**2**	**4**
	Prerequisite				
	Nil				
PURPOSE					
To learn the basic concepts of biomedical signals and to analyze the various signal processing techniques used for biomedical signals.					
INSTRUCTIONAL OBJECTIVES					
1.	To understand the fundamentals of biomedical signals				
2.	To impart knowledge about the neurological signal processing				
3.	To provide a deep knowledge about the cardiological signal processing and analysis				

4.	To apply adaptive filtering techniques for canceling noise and interference in the various Bio-signals
5	To learn about pattern classification techniques and their use in diagnosis

UNIT I- INTRODUCTION TO BIOMEDICAL SIGNALS (9 hours)

Bioelectric signals-Action potential, Electro-neurogram, Electro-oculogram, Electro-encephalogram, Evoked potential, Electro-cardiogram, Electro-gastrogram, bio-impedance signals, mechanical signals - bioacoustics signals, biochemical signals-objectives of biomedical signal analysis, difficulties in biomedical signal analysis.

UNIT II – NEUROLOGICAL SIGNAL PROCESSING (9 hours)

EEG signal and its characteristics, EEG analysis, Linear prediction theory-Autoregressive method, Moving average model, Autoregressive moving average model- Estimation of AR,MA, ARMA parameters. AR modeling of Seizure EEG, Spectral error measure, Adaptive segmentation

UNIT III –CARDIOLOGICAL SIGNAL PROCESSING (9 hours)

ECG data acquisition and lead system, ECG parameters and their estimation, Multi-scale analysis for parameters estimation of ECG waveforms, ECG QRS complex detection-differentiation techniques-Template matching techniques, Arrhythmia analysis monitoring, long term continuous ECG recording

UNIT IV–ADAPTIVE FILTERS FOR NOISE CANCELLATION IN BIOSIGNALS (9 hours)

Adaptive filter- principles, steepest descent algorithm, Widrow-Hoff least mean square adaptive algorithm, Adaptive noise canceller-cancellation of 60Hz interference in ECG- cancelling donor heart interference in Heart-transplant ECG-cancellation of ECG signals from electrical activity of chest muscles- cancelling of maternal ECG from fetal ECG- cancellation of high frequency noise in Electro-surgery. Adaptive line enhancement of diastolic heart sound, Applications of adaptive noise cancelling method to enhance electro gastric measurements.

UNIT V– SIGNAL PATTERN CLASSIFICATION AND DIAGNOSTIC DECISION (9 hours)

Pattern classification, supervised pattern classification- discriminant and decision functions-distance functions-nearest neighbor rule, unsupervised pattern classification-cluster seeking methods, measures of diagnostic accuracy and cost-Receiver operating characteristics-Application: Normal versus Ectopic ECG beats

REFERENCES

1. D.C.Reddy, "*Biomedical Signal Processing: Priniciples and Techniques"*, 2nd edition Tata McGraw-Hill, New Delhi, 2005.
2. N.Vyas, " *Biomedical Signal Processing"* ,First edition, University Science Press, New Delhi 2011
3. Metin Akay, *"Biomedical Signal Processing"*, First edition, Academic Presss Inc,1994
4. Rangaraj.M.Rangayyan, "*Biomedical signal processing"*, First edition, IEEE press, *2002*
5. Joseph..D.Bronzino, "*Biomedical Engineering Handbook"*, 3rd edition CRC Press, 2005

Practical
(30 hours)

LIST OF EXPERIMENTS

1. Basic representation of biomedical signals
2. Applying filtering methods to reduce noise in biomedical signals
3. Applying FFT to obtain Amplitude and phase spectrum
4. Analysis of EEG signal
5. Analysis of ECG signal
6. Detection of QRS complex from ECG signal
7. Analysis of Arrhythmias
8. Adaptive noise canceling
9. Spectral Analysis
10. Term paper implementation

REFERENCES

1. Biomedical signal analysis Lab manual

SEMESTER-II

BM2004	**METHODS OF MEDICAL IMAGE ANALYSIS**	**L**	**T**	**P**	**C**
	Total contact hours - 75	**3**	**0**	**2**	**4**
	Prerequisite				
	Basic knowledge of matrices, differential and integral calculus and Fourier transform				

PURPOSE

To acquire knowledge about fundamental concepts of medical image analysis and apply the image processing techniques in different medical imaging modalities for computer aid diagnosis.

INSTRUCTIONAL OBJECTIVES

1.	To study the basic image fundamentals and transforms applicable in medical image analysis
2.	To gain knowledge about the various image enhancement techniques
3.	To apply various segmentation techniques and algorithms in Medical Images
4.	To acquire knowledge about the medical image registration and fusion techniques
5.	To study the applications of medical image analysis in various imaging modalities

UNIT I – DIGITAL IMAGE FUNDAMENTALS AND TRANSFORMS (9 hours)

Elements of visual perception, Image formation model, image sampling and quantization, some basic relationships between pixels, matrix and singular value representation of discrete images, Image transforms-2DDFT-DCT-DST-walsh-Hadamard-Haar-Slant-KL and their properties.

UNIT II –IMAGE ENHANCEMENT (9 hours)

Gray level transformation, Histogram processing, enhancement using arithmetic/logic operation, spatial filtering –smoothening and sharpening, filtering in frequency domain-smoothening and sharpening frequency domain filters- homomorphic filtering

UNIT III -IMAGE SEGMENTATION AND FEATURE EXTRACTION (9 hours)

Intensity based segmentation, Edge based segmentation, Region based segmentation, segmentation by morphological watersheds, simple active contour models-snake algorithm, k means clustering, Feature extraction-GLCM method, Color image segmentation methods, neural network approach for classification

UNIT IV- MEDICAL IMAGE REGISTRATION AND FUSION (9 hours)

Introduction-dimensionality transformations -image registration algorithms-surface based registration-head and hat algorithm, iterative closest point algorithm, image fusion-pixel based fusion-PCA based image fusion –wavelet transform based image fusion

UNIT V- APPLICATIONS OF MEDICAL IMAGE ANALYSIS (9 hours)

CT image reconstruction, MRI image reconstruction, Angiographic image analysis, Fat segmentation in MRI images, Retinal image analysis, Fusion of PET-CT images,

REFERENCES

1. Rafael C., Gonzalez and Richard E. Woods, "*Digital Image Processing"*, Pearson Education Asia, Third Edition, 2007
2. Anil K. Jain, "*Fundamentals of Digital Image Processing"*, Prentice Hall of India, 2nd edition, 1997
3. Joseph V.Hajnal, Derek L.G.Hill, David J Hawkes, *"Medical image Registration",* Biomedical Engineering series, CRC press,2001.
4. H.B.Mitchell, "*Image fusion Theories and Applications*", Springer verlag Berlin Heildelberg, 2010.
5. Geoff Dougherty, "*Signals and communication technology Medical image processing: Techniques and applications*", Springer, 2011.

Practical
(30 hours)

LIST OF EXPERIMENTS

1. Fundamentals of medical image analysis
2. Gray level transformation and histogram processing of X-ray images.
3. Noise removal and filtering in various medical images.
4. Pixel based segmentation of MRI images
5. Edge based segmentation of CT images.
6. Morphological operations on x-ray images.
7. Statistical feature extraction on X-ray and CT images.
8. Medical Image registration.
9. Vessel extraction in angiographic images using MIMICS software.
10. Geometrical measurements in Medical images using MIMICS software.

11. Conversion of 2D to 3D CT and MRI images using MIMICS software.
12. Color image Segmentation – Implementation in medical images

BM2005	**PHYSIOLOGICAL MODELING AND COMPUTATION**	**L**	**T**	**P**	**C**
	Total Contact Hours – 75	**3**	**0**	**2**	**4**
	Prerequisite				
	Basic knowledge in physiological systems and control system				

PURPOSE	
Students can understand how to design a model for physiological systems, implement and analyze those using MATLAB Tools.	
INSTRUCTIONAL OBJECTIVES	
1.	To understand about models and analogs in different systems.
2.	To gain knowledge about linear, non linear, distributed and lumped parameter models.
3.	To analyze the response of the system by any methods like frequency response, transient response and steady state responses
4.	To learn simulation of models using MATLAB tools
5.	To design a model, simulate and analyze any kind of physiological systems

UNIT I - INTRODUCTION TO PHYSIOLOGICAL MODELING (9 hours)

Model- Definition, various analogs, Physiological systems-A simple example, Generalized system properties- Resistance, Compliance, Impedance, Across variable, through Variable, Models with combination of system elements, Linear- vs nonlinear- models of physiological systems, Action potentials Hodgkin-Huxley model by MATLAB tools, Distributed Vs Lumped parameter models, Compartment models

UNIT II - FREQUENCY DOMAIN ANALYSIS AND TRANSIENT RESPONSE ANALYSIS (9 hours)

Frequency domain- Linearized model of lungs mechanics and their SIMULINK implementation, model of chyne-stokes breathing, circulatory control model, cardiac output, glucose insulin regulation model by MATLAB tools, transient response analysis of neuromuscular reflex model action by MATLAB tools.

UNIT III - MODELING BODY DYNAMICS (9 hours)

Mechanical modeling of bone and tissues, linear muscle model, Study of steady state analysis of muscle stretch reflex action by MATLAB tools, Hills' model of muscle contraction, Oculomotor muscle model, modeling of human movements, Pharmacokinetic modeling with drug diffusion as example

UNIT IV - MODELING OF EYE AND HOMEOSTATIC SYSTEMS (9 hours)

Eye movement system and Wetheimer's saccade eye model, closed loop aspects of papillary control system, Open loop papillary response of papillary-retinal system, Homeostatic lumped model of physiological thermal system, models of heat transfer between subsystems of human body, Homeostatic control of adrenocortical secretion.

UNIT V – NON PARAMETRIC AND PARAMETRIC MODELING (9 hours)

Non parametric models- Volterra models, Wiener models, Parametric Models – Basic parametric model forms and estimation procedures, Volterra Kernels of non linear differential equations, Discrete time Volterra Kernels of NARMAX models.

REFERENCES

1. William B. Blesser, *"A System approach to Bio-medicine",* McGraw-Hill book co., New York, 2nd Edition, 1981
2. Michael C. K. Khoo, "*Physiological control systems: Analysis, Simulation and Estimation",* Prentice-Hall of India Pvt. Limited, first edition, 2000.
3. Manfreo clynes and john H.Milsum, "*Bio-medical engineering system"* McGraw-Hill book co., NewYork, first edition, 1970.
4. Douglas S. Regs, "*Control theory and physiological feedback mechanism"* The William & Williams co., Baltimore, first edition, 1970.

Practical
(30 hours)

LIST OF EXPERIMENTS

1. SIMULINK model of simple lung mechanics
2. Simulation of Hodgkin – Huxley model of nerve membrane
3. Steady state analysis of muscle stretch reflex model
4. SIMULINK model to determine the steady state operating point of the ventilatory control system
5. Second order lung mechanics model to a unit impulse
6. SIMULINK implementation of neuromuscular reflex model
7. SIMULINK model of circulatory control
8. SIMULINK model of blood glucose-insulin regulations

9. Frequency responses of the linearized ventilatory control by Nyquist plots
10. Cardiovascular variability model with feedback

REFERENCES

1. Physiological Modeling and Computation Lab Manual
2. Michael C. K. Khoo, *"Physiological control systems: Analysis, Simulation and Estimation",* Prentice-Hall of India Pvt. Limited, First Edition, 2000.

BM2006	**BIOMECHANICS AND FINITE ELEMENT ANALYSIS**	**L**	**T**	**P**	**C**
	Total Contact hours - 75	**3**	**0**	**2**	**4**
	Prerequisite				
	Basic knowledge in biomechanics and fundamentals of finite element analysis				

PURPOSE	
To provide the knowledge of mechanics of human movement and finite element analysis	
INSTRUCTIONAL OBJECTIVES	
1.	To study about the bone structure and functions of skeletal muscle
2.	To study the structure, movements, and loads applied on Upper Extremity and Lower Extremity
3.	To study about the Linear and Angular kinetics and kinematics of human movement
4.	To understand the fundamentals of finite element analysis
5.	To implement the fundamental processing of Ansys

UNIT I – KINEMATICS AND KINETICS FOR ANALYZING HUMAN MOTION AND BONE GROWTH (9 hours)

Forms of motion – Standard reference terminology – Joint movement: Terminology – Qualitative analysis of human movement–Tools for measuring kinematics quantities – Basic concepts related to kinetics – Mechanical loads on human body – Effects of loading – Tools for measuring kinetic quantities – Composition and structure of bone tissue – Bone growth and development – Bone response to stress – Osteoporosis

UNIT II – BIOMECHANICS OF HUMAN LOWER EXTREMITY AND UPPER EXTREMITY (9 hours)

Human Upper Extremity (Shoulder, Wrist, and Joints of hand): Structure and movements, loads on the region, and common injuries;
Human Lower Extremity (Hip, Knee, and Ankle): Structure and movements, loads on the region, and common injuries;

UNIT III – BIOMECHANICS OF SPINE, LINEAR AND ANGULAR KINETICS AND KINETMATICS OF HUMAN MOVEMENT (9 hours)

Spine: Structure, movements, muscles, and loads on the region – Common injuries of back and neck – Newton's Laws – Mechanical behavior of bodies in contact work – Power, and energy relationships – Resistance to angular acceleration – Linear kinematic quantities – Acceleration – Kinematics of projectile motion – Factors influencing projectile trajectory – Analyzing projectile motion – Angular kinematic relationships – Relationships between linear and angular motion.

UNIT IV – BASICS OF FINITE ELEMENT ANALYSIS (9 hours)

Introduction–Basic equations in Elasticity – Matrix displacement formulation–Element shapes, nodes, nodal unknowns and coordinate systems–shape functions–strain displacement matrix – Linear elements – quadratic elements–– analysis of one dimensional problem – rectangular elements – linear triangular elements .

UNIT V – ANSYS SOFTWARE AND FINITE ELEMENT METHOD (9 hours)

Introduction – fundamentals of ANSYS, and discretization – modeling operations – solid modeling – Boolean operators – additional operations – viewing of model – meshing –ANSYS solution and post processing – case studies in biomechanics.

REFERENCES

1. Susan .J. Hall, "*Basic biomechanics"*, Tata Mcgraw Hill, Sixth edition, 2011.
2. J. G Webster, "*Medical instrumentation –Application & design"*, John Wiley and sons Inc. Fourth edition, 2010.
3. D. J. Schneck and J. D. Bronzino, "*Biomechanics- Principles and Applications"*, CRC Press, Second Edition, 2000.
4. Duane Knudson, "*Fundamentals of Biomechanics"*, Springer, Second Edition, 2007.
5. S.S. Bhavikati, *"Finite element analysis"*, New Age International Ltd, First edition, 2005
6. Tirupathi R. Chandrupatla, Ashok D. Belegundu*, "Introduction to finite elements in Engineering"*, Pearson education, First edition, 2011

7. Saeed moaveni, "*Finite element analysis theory and application with ANSYS"*, Prentice hall, Third edition, 2007.
8. Erdogan Madenci ,Ibrahim Guven, "*The finite element method and applications in engineering using Ansys"*, Springer, First edition, 2006.

Practical
(30 hours)

LIST OF EXPERIMENTS

1. Introduction of FEA
2. Introduction to finite element analysis softwares
3. Basic tutorials of FEA softwares
4. Extraction of 3D models from CT/MRI scan through softwares
5.Finite element analysis of upper extremity bones.
6. Finite element analysis of lower extremity bones.

REFERENCES

1. Biomechanics and Finite Element Analysis Lab Manual

SEMESTER - III

BM2048	**INDUSTRIAL TRAINING I**	**L**	**T**	**P**	**C**
	3 week practical training in industry	**0**	**0**	**1**	**1**
	Prerequisite				
	Nil				

PURPOSE	
To provide hands-on experience at site where biomedical equipments are manufactured and utilized (Hospitals)	
INSTRUCTIONAL OBJECTIVES	
1.	To enable the students to gather a first hand experience on usage of various biomedical equipments.
2.	To be familiar with various medical imaging techniques.
3.	To gain some practical experience in servicing the equipments.

An industrial training of minimum two weeks has to be undergone by the student in the winter/summer
vacation of the I/II semester. They can choose either one of the following: i). Biomedical Industry; ii). Multispeciality Hospital; iii). Government Medical Hospital; and iv). Private/Government R&D Medical Division. After the training, they have to submit a report in the given prescribed format along with a copy of the certificate. During the pass or fail examination, student has to give a power point presentation about the training.

BM2049	PROJECT WORK PHASE I	L	T	P	C
	Prerequisite	0	0	12	6
	Nil				

PURPOSE

To simulate real life situations related to Biomedical Engineering and impact adequate training so that confidence to face and tackle any problem in the field is developed in the college itself.

INSTRUCTIONAL OBJECTIVES

1.	To identify broad area, knowledge gap in current technology through Literature review.
2.	To identify specific area and finalizing the topic
3.	To find solution for the problem specified in hardware and software aspects.

Students have to identify a suitable topic in the specialization which he/she has chosen. With the help of available literature, students have to find the knowledge gap in the chosen topic both at the National and International level. All the literature referred has to be properly cited.

The students can choose any one of the following for the project i). Biomedical Industry; ii). Multispeciality Hospital; iii). Government Medical Hospital; and iv). Private/Government R&D Medical Division.

Title of the project has to be finalized. At least 30 % of the technicalities of the project has to be completed in the Phase – I of the project. Change of title during Project Work Phase-II will not be permitted.
The method of assessment for Phase I is shown in the following table:

Assessment	Tool	Weightage
In- semester	I review	10%

	II review	15%
	III review	35%
End semester	Final viva voce examination	40%

SEMESTER – IV

BM2050	PROJECT WORK PHASE II	L	T	P	C
	Prerequisite	**0**	**0**	**32**	**16**
	Nil				

PURPOSE	
To simulate real life situations related to Biomedical Engineering and impact adequate training so that confidence to face and tackle any problem in the field is developed in the college itself.	
INSTRUCTIONAL OBJECTIVES	
1.	To design and develop an equipment
2.	To carry out clinical trials with the developed product
3.	To publish the completed project work in a National / International Conference / Journal with an impact factor.

An extensive study Project Work Phase-I should continue. At the end of the Phase – II, the student is expected to produce a working prototype of the project (hardware). If the project is software oriented then the complete algorithm and results have to be evaluated. Students have to attend regular reviews and update the status of the project. Attendance of reviews and interaction with Guide carry significance.

There should be no redundancy in the project work. The method of assessment for Phase II is shown in the following table:

Assessment	**Tool**	**Weightage**
In- semester	I review	10%
	II review	15%
	III review	35%
End semester	Final viva voce examination	40%

Student will be allowed to appear in the final viva voce examination only if he / she has submitted his / her project work in the form of paper for presentation / publication in a conference / journal and produced the proof of acknowledgement of receipt of paper from the organizers / publishers.

PROGRAM ELECTIVE COURSES

A) NATIONAL INSTRUMENTS CERTIFIED BIOMEDICAL ENGINEER

BM2101	**LABVIEW – GRAPHICAL SYSTEM DESIGN PLATFORM**	**L**	**T**	**P**	**C**
	Total contact hours – 45	**3**	**0**	**0**	**3**
	Pre-requisite				
	Nil				

PURPOSE	
LabVIEW software is ideal for any measurement and control system, and the heart of the NI design platform. Integrating all the tools that engineers and scientists need to build a wide range of applications in dramatically less time, LabVIEW is a development environment for problem solving, accelerated productivity, and continual innovation. In this subject, you will learn Graphical programming techniques to build any system which requires measurement and control. This subject also will enable the students to take up globally recognized certification exam conducted by National Instruments USA.	
INSTRUCTIONAL OBJECTIVES	
1.	To educate about basic concepts of LabVIEW
2.	To make them understand programming concepts LabVIEW & G Programming
3	To provide an insight to various common measurements and control techniques
4	To enable them to take up CLAD Certification from National Instruments (NI), USA
5.	To impart knowledge on hybrid programming

UNIT I- LABVIEW PROGRAMMING PRINCIPLES & ENVIRONMENT (8 hours)

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 (10 hours)

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 (9 hours)

Local, global, and shared variables – DataSocket - 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 (10 hours)

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 (8 hours)

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, and references

REFERENCES

1. Gary Jonson, '*Labview Graphical Programming'*, McGraw Hill, New York, Fourth edition 2006.
2. Lisa K. wells & Jeffrey Travis, '*Labview for everyone'*, Prentice Hall Inc., First edition 1997.
3. S. Gupta, J.P: Gu.pta, *'PC interfacing for Data Acquisition & Process Control'*, Instrument Society of America, Second Edition, 1994
4. www.ni.com/clad

BM2102	SYSTEM ANALYSIS TECHNIQUES	L	T	P	C
	Total contact hours – 45	3	0	0	3
	Pre-requisite				
	Nil				

PURPOSE

Modern-day systems are getting increasingly intelligent, which in turn increases the complexity of the system. This is true for systems in various domains, such as energy, bio-medical, mechanical, electrical and communication. As time to market pressure mounts, designers have to choose the right type of system analysis tools which scales from design to verification and validation and production. As engineers and researchers, we should be aware of efficient data analysis techniques in our respective fields.

INSTRUCTIONAL OBJECTIVES

1.	To educate about the basic concepts of system design
2.	To make them understand importance of data analysis techniques.
3	To provide an insight to various model analysis techniques are commonly used in analyzing biomedical systems.
4	To enable students to implement system analysis techniques
5.	To impart knowledge on various analysis tools

UNIT I- INTRODUCTION TO GRAPHICAL PROGRAMMING LANGUAGE (8 hours)

Virtual instrumentation (VI): Evolution, Definition, Architecture- Conventional-, and Distributed- VI, Comparison of VI with traditional Instruments, Need of VI, advantages, block diagram, data flow techniques, graphical programming, Comparison between graphical programming and conventional programming, VI in engineering process.

UNIT II- PROGRAMMING MODES IN VIRTUAL INSTRUMENTATION (VI)

(10 hours)

VI: Front panel, block diagram, LabVIEW Environment: Startup-, Shortcut-, and Pull down menu, Palletes, Control structures: FOR loop, WHILE loop, Shift Registers, feedback nodes, Selection Structures: Case and sequence structures, Formulae nodes, Arrays, Clusters, Waveform Chart and graph, XY Graph, Strings, Tables, File I/O functions.

UNIT III- HARDWARE ASPECTS OF VI SYSTEM (9 hours)

Digital I/O Techniques: pull-up and pull down resistors, TTL to solid state Relays, Voltage dividers, data acquisition in LABVIEW, hardware installation and configuration, Data acquisition (DAQ): Components, Accessories, Hardware, and Software**.**

UNIT IV- COMMON DESIGN TECHNIQUES (10 hours)

Signal Generation – Linear Algebra, Singular Value Decomposition – Cholesky Decomposition – Fourier Transforms – Filtering – Differential Equation Solvers – Curve fitting and interpolation techniques

UNIT V- SYSTEM DESIGN IN MEDICAL APPLICATION (8 hours)

Introduction to Biological system and system parameters - ECG acquisition for long term monitoring of heart rate using VI – Architecture of system design – Elements involved in system design

REFERENCES

1. Nasser Kehtarnavaz, "*Digital Signal Processing System-Level Design Using LabVIEW",* Newnes, ISBN: 0-7506-7914-X, 1st edition, 2005
2. Cory L. Clark, *"LabVIEW Digital Signal Processing",* McGraw-Hill, 1st edition, 2005
3. Leonard Sokoloff , "Applications in LabVIEW", Prentice Hall, 1st edition, 2003
4. Jon.B.Olansen and Eric Rosow, *"Virtual Bio-Instrumentation – Biomedical, Clinical and Healthcare Applications using LabVIEW"*, Prentice Hall, first edition, 2002.
5. Jeffrey Travis,*"Internet Applications in LabVIEW,* Prentice Hall, first edition, 2000.

BM2103	INTELLIGENT INSTRUMENTATION	L	T	P	C
	Total contact hours – 45	3	0	0	3
	Prerequisite				
	Nil				

PURPOSE	
To impart adequate knowledge on measurement and instrumentation technology	
INSTRUCTIONAL OBJECTIVES	
1.	To educate about the basic concepts of sensors & transducers
2.	To make them understand the importance of PC based measurements
3	To provide an insight to various common measurements & instrumentation techniques
4	To enable them to implement intelligent instrumentation system
5.	To impart knowledge on various instrumentation tools

UNIT I- INTRODUCTION TO SENSORS & TRANSDUCERS (8 hours)

Review of Transducers, Principles of operations and its classification, Characteristics, Technological trends in making transducers, Silicon sensors for the measurement of pressure, Level, Flow and Temperature, Bio-sensors, types and its Application. Radiation Sensors, X -ray and Nuclear radiation sensors, Fiber optic sensors for Temperature, Liquid level, Fluid- flow measurement, Electro-analytical sensors: Electrochemical cell, Standard hydrogen electrode (SHE), Smart sensors

UNIT II – COMMON INSTRUMENT INTERFACES (9 hours)

4 – 20 mA current loop, RS 232, SR422, RS485, GPIB, VISA, USB, PCI, PCI Express, PXI, PCMCA, SCXI, VXI, LXI.

UNIT III- INTRODUCTION TO MEASUREMENT TECHNOLOGY (10 hours)

Introduction about Instrumentation systems, Types of Instrumentation systems, Data acquisition system and its uses in intelligent Instrumentation system, Detailed study of each block involved in making of DAS, Signal Conditioners: as DA, IA, Signal converters (ADC & DAC), Sample and hold, Designing of Pressure, Temperature measuring instrumentation system using DAS, Data logger.

UNIT IV- AUTOMATION SYSTEMS DESIGN (9 hours)

Automation system, Concepts of control schemes, Types of controllers, Components involved in implementation of automation system i.e., DAS, DOS, Converter (I to P) and Actuators: Pneumatic cylinder, Relay, Solenoid (Final control element), Computer supervisory control system (SCADA), Direct digital control's structure and software-

Introduction of Programmable logic controller, Principles of operation, Architecture of programmable automation controllers, Programming the programmable controller.

UNIT V- INTELLIGENT CONTROL SYSTEMS DESIGN ITS APPLICATIONS

(8 hours)

Intelligent controllers, Model based controllers, Predictive control, Artificial intelligent based systems, Experts controller, Fuzzy logic system and controller, Artificial neural networks (ANN)- Cardiovascular pressure – Dimension analysis system, Cardiopulmonary measurement system, a real time research tool for data acquisition, analysis and display of ventilatory parameters. .

REFERENCES

1. Krishna Kant, "Computer-Based Industrial Control", Prentice Hall of India, 10th edition, 2009.
2. Curtis D Johnson, "Process Control Instrumentation Technology", Pearson, 6th Edition, 2006.
3. D. Patranabis, "Sensors and Transducers", Prentice Hall of India, 2nd Edition,1984.
4. H. S. Kalsi , "Electronics instrumentation", Tata Mc Grow Hill education Pvt. Ltd., 3rd edition 2010.
5. Jon. B. Olansen and Eric Rosow, *"Virtual Bio-Instrumentation – Biomedical, Clinical and Healthcare Applications using LabVIEW",* Prentice Hall, first edition, 2002.

BM2104	**MEDICAL ROBOTICS AND AUTOMATION**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Basic knowledge in Equipments, Sensor, Control system and Instrumentation				
PURPOSE					
To provide comprehensive knowledge of robotics in the design, analysis, automation and control point of view.					
INSTRUCTIONAL OBJECTIVES					

1.	To study the basics of robotics, kinematics and dynamic.
2.	To study various motion planning and control.
3.	To Know about various sensor used in planning and control for robotic system.
4.	To Provide knowledge about various mobile and distributed robotics.
5.	To understand the basics of medical automation and medical robotics.

UNIT I -ROBOTICS FOUNDATION (8 hours)

Definition and origin of robotics – different types of robotics -various generations of robots– degrees of freedom, Kinematics: position and orientation representation -joint kinematics-inverse kinematics-forward instantaneous kinematics- inverse instantaneous kinematics- Dynamic: Spatial vector notation, dynamic model of rigid body system, kinematic tree, and kinematic loop.

UNIT II – MOTION PLANNING AND CONTROL (9 hours)

Motion planning: Motion planning concept- sampling based planning- Motion control: Introduction to motion control- join spaces verses operational space control- independent join control- PID control- tracking control- computed torque control- Adaptive control- optimal and robust control- digital implementation- learning control- indirect force control- hybrid force control.

UNIT III – SENSOR BASED PLANNING AND CONTROL (9 hours)

Force and tactile sensor- Inertial sensor- GPS and Odometry: Odometry, gyroscopic system, GPS, IMU integration- Sonar sensor: CTFM sonar-Multipulse sonar- sonar ring- Bio-mimetric sonar- Range sensor- Visual servoing and visual tracking: Basic component of visual servoing- Image based visual servo- Position based visual servo- Performance optimization and planning- Estimation of 3D parameters.

UNIT IV–MOBILE AND DISTRIBUTED ROBOTICS (10 hours)

Motion control of wheeled mobile robots- Motion planning and obstacle avoidance: Non-holonomic mobile robots-Motion planning and obstacle avoidance- Definition of Obstacle avoidance- Obstacle avoidance technique. Distributed and cellular robots: Modularity for locomotion-Modularity for manipulation- modularity for geometric configuration and robot system. Multiple mobile robot system: Architecture for multi robot system-swarm robot- heterogeneity- task allocation-learning.

UNIT V–AUTOMATION AND MEDICAL ROBOTICS (9 hours)

Introduction of medical automation-Application of automation: Bar coding- RFID and wireless tracking- Human factor issue with automation- Medical robotics and

computer integrated surgery, Rehabilitation and health care robotics: Physical therapy and training robots- Aids for people with disability- Smart prosthesis and orthosis- Augmentation for diagnosis and monitoring safety ethics.

REFERENCES

1. Brunosciliano,Oussama Khatib, "*Springer Handbook of Robotics*", springer-verlag berlin Heidelberg, First Edition, 2008.
2. Robin felder, "*System Engineering Approch to automation*", Artech House Inc, First Edition, 2008.
3. Mikell P. Weiss G.M., Nagel R.N, Odraj N.G., " *Industrial Robotics*", McGraw-Hill Singapore, First Edition,1996.
4. Ghosh, "*Control in Robotics and Automation: Sensor Based Integration*", Allied Publishers,Chennai, First Edition, 1998.
5. Nagrath and Mittal, "*Robotics and Control*", Tata McGraw-Hill, First edition 2003.
6. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, "*Robotics, control, sensing, Vision and Intelligence*", McGraw Hill International, First edition, 2008.

BM2105	**NI LABVIEW CERTIFICATION: CERTIFIED LABVIEW EMBEDDED SYSTEMS DEVELOPER (CLED) - PART 1**	**L**	**T**	**P**	**C**
	Total contact hours – 45	**3**	**0**	**0**	**3**
	Pre-requisite				
	Should be CLAD and CLD certified				

PURPOSE

To demonstrates proficiency and expertise in analyzing requirements for and designing, developing, debugging, and deploying reliable mission-critical embedded control and monitoring applications based on NI Compact RIO, NI Single-Board RIO and/or NI R Series hardware. A CLED efficiently uses the NI LabVIEW Real-Time and LabVIEW FPGA modules in accordance with NI-recommended best practices and software engineering principles to design modular, scalable, and maintainable embedded systems.

INSTRUCTIONAL OBJECTIVES

1.	To educate about the Importance of System Design
2.	To make them understand the embedded system architecture
3	To provide an insight to Real Time and FPGA Programming
4	To enable them to design embedded system design applications

UNIT I- LABVIEW REAL- TIME & SCAN ENGINE (8 hours)

Thread priorities - Priority inversion, shared resources, and starvation - Execution systems and their relation to threads and priority - VI priority versus timed loop priority - OS thread priority - Analyze application requirements and their relation to priorities - Error handling and logging - Multi-core programming - Apply and select between NI Scan Engine, Hybrid Mode, or LV FPGA Mode - Understand scan engine timing consideration - Handle scan engine faults

UNIT II- LabVIEW FPGA & DATA COMMUNICATIONS (10 hours)

Emulation mode - Arbitration - Buffering techniques for DMA FIFOs - Fixed-point data type for FPGA operations - Enable chain - FPGA optimization for space/size - FPGA optimization for performance (throughput & SCTL) - Compile report - Commands, tags, and streaming - Best practices for communications with the following: Tags, Network streams, Command/message, FPGA interprocess- TCP and UDP - UDP multicast and broadcast - Client-server

UNIT III- HARDWARE SYNCHRONIZATION & RELIABILITY (9 hours)

FPGA – via shared backplane bus - Clocks synchronization for distributed systems - NI Time sync and SMTP protocol - Failure modes, failure states - Redundancy - Error logging - Alarming - LabVIEW Real-Time Watchdog - LabVIEW FPGA watchdog - Acknowledgement based reliable communication - System health monitoring and maintenance - Identify components that allocate memory - Identify which non-application components (DMA, drivers, TCP) affect memory - Memory fragmentation and its impact on RT targets - Buffer allocation and it affect on memory - Behavior of LabVIEW Real-Time when the system runs out of memory.

UNIT IV- TEST, BENCHMARK AND DEBUG APPLICATIONS (10 hours)

Test system functional requirements - Benchmark uptime, throughput, and data rates - Debug and /or benchmark thread and VI execution, Benchmark memory usage, CPU usage, execution time, throughput, latency, jitter, and FPGA usage - Interpret a compile report to estimate if a FPGA program will fit on FPGA - Prepare system for benchmarking by removing unused software components from OS, Debug / extract benchmarking info from a headless system by using console, syslog and other tools - Create a system image for replication - Utilize System Config tools for deployment - Deploy NI Scan Engine and shared variables settings - Deploy software and runtime updates - Deploy updates that are deployed on reboot.

UNIT V- INTEGRATION LABVIEW WITH OTHER MODULES (8 hours)

Log and display alarm, event and historical trend data with the LabVIEW DSC Module

REFERENCES

1. Gary Jonson, "*Labview Graphical Programming*", McGraw Hill, New York, Fourth edition 2006.
2. Lisa K. wells & Jeffrey Travis, "L*ab view for everyone'*, Prentice Hall of India., New Jersey; First edition 1997.
3. www.ni.com/cled
4. Compact RIO development manual
5. www.ni.com/rt
6. www.ni.com/fpga

BM2106	**NI LABVIEW CERTIFICATION: CERTIFIED LABVIEW EMBEDDED SYSTEMS DEVELOPER (CLED) - PART 2**	**L**	**T**	**P**	**C**
	Total contact hours – 45	**3**	**0**	**0**	**3**
	Prerequisite				
	CLED Part 1 completed				

PURPOSE

To demonstrates proficiency and expertise in analyzing requirements for and designing, developing, debugging, and deploying reliable mission-critical embedded control and monitoring applications based on NI Compact RIO, NI Single-Board RIO and/or NI R Series hardware. A CLED efficiently uses the NI Lab VIEW Real-Time and Lab VIEW FPGA modules in accordance with NI-recommended best practices and software engineering principles to design modular, scalable, and maintainable embedded systems.

INSTRUCTIONAL OBJECTIVES

1.	To educate about the importance of system design
2.	To make them understand embedded system architecture
3	To provide an insight to real time and FPGA programming
4	To enable them to implement embedded system design applications

UNIT I- LabVIEW SOFTWARE DESIGN & DEVELOPMENT WITH HMI (8 hours)

Develop system design - Design modular, scalable, maintainable and well documented software - Apply best practice guidelines communicated in related

National Instruments training and documentation in all phases of the project - Utilize standard debugging tools throughout development - Install minimal software set to target - Handle user interface events with minimal latency - Manage configuration data (recipes, parameters, etc) - Group data in meaningful date structures - Display I/O data in a waveform graph - Display system health data in a waveform graph

UNIT II- LABVIEW RT & FPGA DESIGN (10 hours)

Design a recipe engine - Leverage standard design patterns - Select the most appropriate scalable method for interprocess communication - Monitor available memory and memory fragmentation - Develop and implement mechanisms to log alarms and events - Define and design and control algorithm (IO variables, process variables, set points) - Implement custom control (PID, hysteresis or interlock type control) - Use no more than 70% of the FPGA fabric (interpret compile report, optimize if needed) - Develop data communication between FPGA and RT

UNIT III- NETWORK COMMUNICATION (9 hours)

Specify and select communications protocols based on application requirements - Send buffered commands from user interface to RT target with minimum latency - Incorporate acknowledgements into the command sender framework - Handle network communication in processes separate from any deterministic or event-based processes - Send current value data of I/O channels to user interface with minimum overhead - Send current value of RIO system health variables to user interface with minimum overhead- Manage multiple clients - Local host plus a supervisory host - One active and passive client, Real-Time application reports, handles and logs at least two classes of errors.

UNIT IV- FILES LOGGING & FAILURE MODES (10 hours)

Manage recipe configuration data - Develop strategy to transfer data from target to host - Develop file spanning method to minimize data loss - Manage file logging on target and host - Design system with multiple safe states - FPGA outputs go into a safe state upon watchdog and I/O node error - Design ramp down conditions, versus setting outputs to zero - Reboot system when memory gets low - Utilize bi-directional RT and FPGA watchdog

UNIT V- DETERMINISIM, PERFORMANCE & DEPLOYMENT (8 hours)

Avoid dynamic memory allocations within deterministic processes - Shared resources within any deterministic processes set to"skip if busy" - Ensure deterministic loops finish on time - Ensure CPU usage stays below 80% - Monitor and ensure contiguous memory stays relativelyconstant - Build application into an exe and set as startup

REFERENCES

1. Gary Jonson, '*Labview Graphical Programming'*, McGraw Hill, New York, Fourth edition 2006.
2. Lisa K. wells & Jeffrey Travis, '*Labview for everyone'*, Prentice Hall India., New Jersey; First edition 1997.
3. www.ni.com/rt
4. www.ni.com/fpga
5. www.ni.com/cld
6. www.ni.com/cled

B) APPLICATION SPECIALIST IN RADIOLOGY

BM2107	MEDICAL IMAGING USING X-RAYS	L	T	P	C
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE

This course is designed to prepare graduates to function as technologists in the field of radiology and processing methods and techniques involved in X-rays.

INSTRUCTIONAL OBJECTIVES

1.	To understand the basic knowledge of generation and production of X-rays.
2.	To study about the steps involved in film processing
3.	To study the processing methods involved in X rays
4.	To impart the knowledge in image quality and computed radiography

UNIT I – INTRODUCTION OF X-RAYS (7 hours)

Atom - Structure of an atom – X-ray interaction with the human body - Attenuation of X Ray -Absorption of energy from X- ray – X-ray radiation unit – X-ray linear mass attenuation coefficient

UNIT II - PRODUCTION OF X-RAYS (11 hours)

X-ray tube -X-ray tube insert, Tube housing, Filtration, and collimation-X-ray generator function and components -X-ray generator circuit designs -Timing the X-ray exposure in radiography -Factors affecting X-ray emission -Power ratings and heat loading -X-ray exposure rating charts .

UNIT III - X-RAY FILM PROCESSING (10 hours)

Screen-Film radiography -Projection radiography - Basic geometric principles -The Screen-Film cassette -Characteristics of screens -Characteristics of film -The screen-Film system -Contrast and dose in radiography -Scattered radiation in projection radiography -Film processing -Film Exposure-The film processor -Processor artifacts -Other considerations-Dry processing -Processor quality assurance.

UNIT IV – IMAGE ENHANCEMENT PROCEDURES (7 hours)

Contrast-Spatial resolution -Noise -Detective quantum efficiency (DQE)-Sampling and aliasing in digital images -Detail curves -Receiver operating characteristics curves -Contrast-Spatial resolution-noise-detective quantum efficiency-Sampling and aliasing in digital images-contrast detail curves-receiver operating characteristics curves

UNIT V – COMPUTED RADIOGRAPHY (CR) AND MEDICAL APPLICATION (9 hours)

Computed radiography -Charged-Coupled devices (CCDs) – Imaging using X-ray contrast agent for GI tract and Iodine based contrast agent – Applications: X-rays of chest, abdomen, pelvis, head, arms and legs.

REFERENCES

1. Jerold T. Bushhery, J. Antony Siebert, Edwin M. Leidholdt, John M Boone, "*The Essential Physics of Medical Imaging*", Lippincott Williams & Wilkins, 3rd Edition 2011.
2. Joseph J. carr & John Brown, *"Introduction to Biomedical Equipment Technology"* Pearson Education, 4th Edition, 2008..
3. R. S. Khandpur, *"Handbook of Bio-Medical Instrumentation",* Tata McGraw Hill 2nd edition, 2003.
4. John. G. Webster's, *"Bioinstrumentation",* John Wiley & Sons 1st edition 2009.
5. Krzysztof Iniewski, "*Medical Imaging: Principles, Detectors, and Electronics*", John Wiley & Sons, 2009.
6. Nadine Barrie Smith and Andrew Webb, "*Introduction to Medical Imaging: Physics, Engineering and Clinical Applications*", Cambridge University Press, 1st Edition, 2011.
7. K.Thayalan, "*Basic Radiological Physics",* Jaypee Brothers Medical Publications, 1st Edition, 2001.

BM2108	**SPECIALIZED X-RAY MEDICAL EQUIPMENTS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE	
This course is designed to describe about various specialized X-ray medical equipments.	
PRE REQUISITE	
INSTRUCTIONAL OBJECTIVES	
1.	To learn about advances in digital radiography
2.	To gain knowledge about digital fluoroscopy and its application.
3.	To understand the working of x-ray digital subtraction angiography.
4.	To study about the working of digital mammography.
5.	To import knowledge in bone densitometry.

UNIT I – DIGITAL RADIOGRAPHY (DR) (9 hours)

Digital Radiography – Basic principle – Flat panel detectors – Types and functions .

UNIT II – DIGTAL FLUOROSCOPY (9 hours)

Fluoroscopy-imaging chain components-fluoroscopic detector systems-automatic exposure rate control-fluoroscopy modes of operation-image quality-radiation dose – Applications.

UNIT III – DIGITAL SUBTRACTION ANGIOGRAPHY (9 hours)

Basic of digital angiography - Image processors for digital angiography - processor architecture – Temporal integration techniques for digital angiography- digital subtraction angiography.

UNIT IV – FULL FIELD DIGITAL MAMMOGRAPHY (9 hours)

X-ray tube design -X-ray generator and photo timer system-Compression, Scattered radiation, and Magnification -Screen-Film cassettes and film processing- Ancillary procedures- Full field digital mammography - Radiation dosimeter -Regulatory requirements

UNIT V – DUAL ENERGY X-RAY ABSORPTIOMETRY BONE DENSITOMETER (9 hours)

X-ray absorptiometry- Bone mineral and soft tissue attenuation coefficients- Single energy x-ray absorptiometry (SXA)- Dual energy x-ray absortiometry (DXA)-Scanner design and operation- Radiation detectors- Total body composition.

REFERENCES

1. Jerold T. Bushery, J. Antony Siebert, Edwin M. Leidholdt, John M Boone, "*The Essential Physics of Medical Imaging*", Lippincott Williams & Wilkins, 3rd Edition 2011.
2. R. S. Khandpur*, "Handbook of Bio-Medical Instrumentation",* Tata McGraw Hill, 2nd edition, 2000
3. Blake GM, Wahner HW and Fogelman I, *"The evaluation of osteoporosis:dual energy x-ray absorptiometry and ultrasound in clinical practice",* London:martin Dunitz ,2nd edition,1999.
4. Bonnick SL.*"Bone densitometry in clinical practice*", Totowa Nj:Humana press ,2nd edition , 2004.
5. Krzysztof Iniewski, "*Medical Imaging: Principles, Detectors, and Electronics*", John Wiley & Sons, 2009.
6. Nadine Barrie Smith and Andrew Webb, "*Introduction to Medical Imaging: Physics, Engineering and Clinical Applications*", Cambridge University Press, 1st Edition, 2011.
7. H. K. Huang, "*PACS and Imaging Informatics: Basic Principles and Applications*", John Wiley and sons,2010

BM2109	**COMPUTER ASSISTED TOMOGRAPHY IMAGING**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE

This course is designed to understand the basic concepts and methodologies behind the computed tomographic imaging. Here, the student will be exposed to various aspects of CT starting from the acquisition, generations, reconstruction methods, dose considerations and image characteristics

PREREQUISITE

INSTRUCTIONAL OBJECTIVES

1.	To facilitate the basic concepts of image acquisition and reconstruction techniques

2.	To understand the concepts behind tomographic reconstruction techniques while considering the image characteristics.
3.	To study about the image display and image quality aspects.
4.	To know the current technology in CT.

UNIT I – BASICS OF COMPUTED TOMOGRAPHY(CT) (9 hours)

Basic principles, tomographic acquisition, reconstruction. Geometry and historical development: Generation of Computed tomography, (sixth and seventh generations).

UNIT II – DETECTORS (9 hours)

Detectors and detector arrays: Xenon detectors, solid state detectors, multiple detector arrays. Details of Acquisition: slice thickness: single detector array scanners, multiple detector array schemes, detector pitch and collimator pitch.

UNIT III – RECONSTRUCTION TECHNIQUES (9 hours)

Back Projection Reconstruction, Filtered Back Projection Reconstruction, Fan Beam Reconstruction, Iterative Reconstruction.

UNIT IV – IMAGE DISPLAY AND QUALITY (9 hours)

Digital Image display: windowing and leveling, 3- D reconstruction, multi-planar reconstruction, stack mode viewing. Radiation Dose: dose measurement, dose considerations in helical scanning, Dose in computed tomographic fluoroscopy, current modulation in computed tomography - Image quality: Spatial resolution, Contrast resolution and Temporal resolution, Aliasing artifacts & noise in CT images.

UNIT V – CURRENT TECHNOLOGY AND APPLICATIONS (9 hours)

Dual Energy CT, Multi-Slice CT, ECG Triggered and ECG gated Cardio-Vascular CT – Artifacts in CT imaging – Applications: Cardiac imaging, Cerebral imaging, Liver imaging, Lungs imaging.

REFERENCES

1. Jerold T. Bushhery, J. Antony Siebert, Edwin M. Leidholdt, John M Boone, "*The Essential Physics of Medical Imaging*", Lippincott Williams & Wilkins, 3rd Edition 2011.
2. M.F. Reiser, C.R. Becker, K. Nikolaou, G.Glazer, '*Multislice CT*', Springer, Third Revised Edition 2009
3. A.L. Baert, M.F. Reiser, H. Hricak, M. Knauth, '*Dual Energy CT in Clinical Practice*', Springer, First Edition 2011

4. Jiang Hsieh, '*Computed Tomography: Principles, Design, Artifacts, and Recent Advances*', Wiley Interscience, Second Edition 2009
5. Gabor T. Herman, '*Fundamentals of Computerized Tomography: Image Reconstruction from projections*', Springer, Second Edition 2010.

BM2110	NUCLEAR MEDICINE	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite				
	Nil				

PURPOSE

This course is designed to prepare graduates to function as technologists in nuclear medicine departments. This subject will enable the students to learn the basic principles of different imaging modalities used in nuclear medicine.

PREREQUISITE

INSTRUCTIONAL OBJECTIVES

1.	To understand the basic physics of various imaging modalities in nuclear medicine.
2.	To gain knowledge about various detectors used in nuclear medicine
3.	To gain knowledge in maintenance, handling and operation of the various equipments in this field.
4.	To understand the basic working principle of Emission Tomography.

UNIT I – BASIC PHYSICS BEHIND RADIOACTIVITY (9 hours)

Physics of Radioactivity: Radionuclide Decay Terms and Relationships – Activity – Physical half Life – Fundamental Decay Equation, Nuclear Transformation – Alpha Decay, Beta-Minus Decay-Beta Plus – Electron Capture – Isomeric Transition – Decay Schemes

UNIT II – PRODUCTION OF RADIOACTIVE ELEMENTS (9 hours)

Radionuclide Production: By cyclotron, nuclear reactor, neutron activation method, and generators, Radiopharmaceuticals – Characteristics, applications, quality control and regulatory issues in medical imaging, Radiopharmaceutical mechanisms of localization

UNIT II – I RADIOACTIVITY DETECTORS (9 hours)

Radionuclide detection and measurement - Type of detectors – pulsed and current mode - spectroscopy, Gas Filled detectors, Scintillation detectors, Semiconductor

detectors, Pulse height spectroscopy, Non– imaging detector applications, Counting statistics

UNIT IV – NUCLEAR IMAGING (9 hours)

Planar Nuclear Imaging: Anger Scintillation Camera – Design and principles of operation- performance – design factors, Computers in Nuclear Imaging – Digital image formats – image acquisition – Image processing in nuclear medicine

UNIT V – EMISSION TOMOGRAPHY AND APPLICATIONS (9 hours)

Nuclear Imaging Emission Tomography: Focal plane tomography - Single photon emission computed tomography (SPECT) – image acquisition – Image reconstruction – attenuation correction in SPECT, Positron emission tomography – Design and principles of operation – 2-D and 3-D acquisition – Comparison of SPECT and PET – Combines X-ray CT and SPECT – Applications: Whole body, Heart and Brain.

REFERENCES

1. Jerrold T Bushberg, J.Anthony Seibert, Edwin M Leidholdt,John M Boone, Lippincott, *"The Essential Physics of Medical Imaging"* Williams & Wilkins,3rd edition,2011
2. S Webb*, "The Physics of Medical Imaging",* Adam Highler, Bristol Published by CRC Press, first edition 1988.
3. Webb's, "*Physics of Medical Imaging", Taylor and Francis Group",* CRC Press,2nd edition, 2012
4. R. S. Khandpur "*Handbook of Bio-Medical Instrumentation",* Tata McGraw Hill, 2nd edition, 2003

BM2111	**ULTRASOUND MEDICAL IMAGING**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				
PURPOSE					
To attain mastery in diagnostic ultrasound techniques used for physiological monitoring					
INSTRUCTIONAL OBJECTIVES					
1.	To impart knowledge about physics of ultrasound				
2.	To study the methods of attaining and storing ultrasound images				

3.	To learn about the various features that can be extracted from ultrasound images
4.	To study about Doppler effect in medicine
5.	To understand the various biological effects of ultrasound and applications of ultrasound in medicine.

UNIT I – PHYSICS OF ULTRASOUND (9 hours)

Characteristics of sound, properties of ultrasound, sources, wave propagation of ultrasound, generation of ultrasound- Interaction of ultrasound with matter, Transducers matching layer, Non-resonance multi-frequency transducers.

UNIT II – IMAGE ACQUISITION AND STORAGE (9 hours)

Beam properties, side lobes and grating lobes, spatial resolution, Image data acquisition: Three dimensional/Four dimensional/Five dimensional imaging - Echo display modes, Scan converter. Electronic scanning and real time display – US contrast agent: Micro bubbles and harmonic & pulse inversion imaging - Image storage.

UNIT III – CHARACTERISTIC FEATURES OF ULTRASOUND IMAGE (9 hours)

Distance, Area, and Volume Measurements, Ultrasound contrast agents, Harmonic imaging, Elastrography, Special purpose transducers assemblies, spatial resolution, contrast resolution and Noise artifact.

UNIT IV – DOPPLER SCANNER AND QUS (9 hours)

Doppler frequency shift, continuous Doppler operation, pulsed Doppler operation, duplex scanning, Doppler spectral interpretation, aliasing, Color flow imaging, Doppler ultrasonic cardiac imaging, power Doppler – Quantitative ultrasound (QUS): Basics, block diagram and measurement of speed of sound and attenuation in bone, evaluation of osteoporosis.

UNIT V – BIOLOGICAL EFFECTS OF ULTRASOUND AND ULTRSOUND APPLICATIONS (9 hours)

Ultrasound quality assurance, Acoustic power and bio-effects: Acoustic power and intensity of pulsed ultrasound, Biological mechanisms and effects - Applications in medicine: Eco-cardiography, Obstetrics and Gynaecology, Breast imaging and Musculoskeletal structures

REFERENCES

1. Jerold T. Bushhery, J. Antony Siebert, Edwin M. Leidholdt, John M Boone, "*The Essential Physics of Medical Imaging*", Lippincott Williams & Wilkins, 3rd Edition 2011.
2. M.A. Flower, "*Webh's Physics of Medical Imaging",* Taylor & Francis, 2nd Edition, 2012.
3. R. S. Khandpur, *"Handbook of Bio-Medical Instrumentation",* Tata McGraw Hill, 3rd Edition, 2000
4. Perter Hoskins, Kevin Martin and Abigail Thrush, "*Diagnostic ultrasound: Physics and Equipment",* Cambridge University Press, 2nd Edition, 2010.

BM2112	**MAGNETIC RESONANCE IMAGING**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE	
To attain adequate knowledge about the principles and diagnostic applications of MRI in medicine.	
INSTRUCTIONAL OBJECTIVES	
1.	To gain knowledge about the basics of nuclear magnetic resonance
2.	To gain a detailed knowledge of the MRI slice selection, data acquisition, Instrumentation and applications of MRI.
3.	To learn about the various data acquisition techniques
4.	To know about MR Image characteristics
5.	To study about the applications of MRI in medicine and current technology.

UNIT I –PHYSICS OF MAGNETIC RESONANCE (9 hours)

Nuclear Magnetic Resonance – Magnetization properties, Generation & detection of Magnetic resonance signal, Instrumentation.

UNIT II – LOCALIZATION (9 hours)

MRI- Localization of MR signals, Magnetic field gradients, slice select gradient, frequency encode gradient, phase encode gradient, gradient sequencing.

UNIT III – DATA ACQUISITION TECHNIQUES (9 hours)

MRI -K space data acquisition, 2D data acquisition, 2D multi-planar acquisition, multi slice data acquisition, fast spin echo acquisition, Inversion recovery, Gradient recalled

echo acquisition, echo planer Image acquisition, gradient moment mulling, 3D Fourier transform image acquisition – MRI contrast agent: Positive-, and Negative- contrast agents – SAR – Lipid suppression techniques.

UNIT IV – QUALITY CONTROL (9 hours)

MRI Image characteristics, Time of flight, phase contrast, Magnetization transfer contrast angiography, Artifacts, Instrumentation, Qualify control, safety & bio-effects in MRI.

UNIT V – CURRENT TECHNOLOGY AND APPLICATIONS (9 hours)

fMRI - Magnetic resonance spectroscopy - Introduction about MR guided ultrasound surgery - Applications of MRI in medicine: Neurology, Musculoskeletal, Cardiology.

REFERENCES

1. Jerold T. Bushery, J. Antony Siebert, Edwin M. Leidholdt, John M Boone, "*The Essential Physics of Medical Imaging*", Lippincott Williams & Wilkins, 3rd Edition 2011.
2. Heggie JCP, Liddell NA & Maher KP, 2001. "*Applied Imaging Technology*", 4th Edition (St Vincent's Hospital: Melbourne)
3. Joseph J. carr & John Brown, *"Introduction to Biomedical Equipment Technology"* Pearson Education, 4th Edition, 2008..
4. Ferenc A. Jolesz & Kullervo H. Hynyne, "*MRI – Guided Forward Ultrasound Surgery",* Informa Healthcare USA, 1st Edition 2008.

C) SALES AND SERVICE BIOMEDICAL ENGINEER

BM2113	**DESIGN OF MEDICAL ELECTRONIC DEVICES**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Basic knowledge in electronic devices				

PURPOSE	
The purpose of this course is to impart knowledge in the universal design consideration for medical devices	
INSTRUCTIONAL OBJECTIVES	
1.	To gain knowledge about data acquisition, noise reduction and protection techniques
2.	To get an idea about the product level design in medical field

3.	To understand the basic designing concepts for diagnostic, therapeutic equipments
4.	To understand the basic designing concepts for implants and Prosthesis

UNIT I - DATA ACQUISITION AND NOISE ISSUES (9 hours)

Physical Principles of Sensing, Sensor Interfacing, Driving Bridges, Signal Conditioning Amplifiers, Data Acquisition: Sample and Hold Conversion, Multi channel Acquisition, Internal Noise In OPAMPS, Bypass Capacitors and Resonances, Electromagnetic Interference, interference from external electric field, conductive interference, electrical safety and signal isolation, Overload Protection, Output Filtering, Power Failure Warning

UNIT II - DESIGN METHODOLOGIES (9 hours)

EDR design methodologies, PCB assembly, mechanical assembly, product design amd modeling, fabrication and assembly, Multi-layer circuit design, Advanced OrCAD design, Design rule specifications

UNIT III – DIAGNOSTIC EQUIPMENT DESIGN (9 hours)

ECG, EEG, Blood pressure monitor, Thermometer, System description and diagram of pulse oximeter, Optical fiber optics for circulatory and respiratory system measurement, Magnetic resonance imaging (MRI) Hardware design

UNIT IV - THERAPEUTIC EQUIPMENT DESIGN (9 hours)

Pacemaker, External cardio-vector defibrillator, Implantable cardio-vector defibrillator, Deep brain stimulation, Functional electrical stimulator (FES), Hemodialysis delivery system, Mechanical ventilator

UNIT V - IMPLANT AND PROSTHESIS DESIGN (9 hours)

Intraocular lens implant, Cochlear implants, Heart valves, Design of artificial pancreas, Drug eluting stent and its engineering design, synthetic crafts, Total hip prosthesis, Joint replacement

REFERENCES

1. Gail Baura, "*Medical Device Technologies: A Systems Based Overview Using Engineering*", Elsevier science, 2002
2. Martin Culjat, Rahul Singh, Hua Lee, *"Medical Devices: Surgical and Image-Guided Technologies*", John Wiley & Sons, Reinaldo Perez, "*Design of medical electronic device*", Elsevier science, 2002.

3. Richard C. Fries, "*Handbook of Medical Device Design*", Marcel Dekker AG, 2nd edition 2005.
4. Anthony Y.K.Chan, "*Biomedical device technology: principles and design*", Charles C Thomas, 2008.
5. Theodore R. Kucklick, "*The Medical Device Ramp-D Handbook*", Taylor &Francis Group LLC, 3rd edition 2013.
6. David Prutchi, Michael Norris, *"Design and Development of Medical Electronic Instrumentation: A Practical perspective of the design, construction and test of medical devices*", John Wiley & Sons, 2005

BM2114	**THERAPEUTIC AND SURGICAL INSTRUMENTS**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Basic knowledge in electronic devices				

PURPOSE

This subject will enable the students to learn therapeutic and surgical instruments/ equipment used in the health care industry. It helps for servicing and production of health care industry.

INSTRUCTIONAL OBJECTIVES

1.	To study about the infant care therapeutic devices
2.	To obtain technical knowledge of infusion devices
3.	To learn the basic physiotherapy equipments
4.	To study about surgical and O.T (operation theatre) equipments
5.	To study about the scopy equipments

UNIT I – NEONATAL CARE THERAPAUTIC EQIPMENT (9 hours)

i). Baby incubator, ii). Phototherapy; and iii). Radiant warmer: Working principle, block diagram, description, and function of basic blocks of unit, fault indication, alarms interpretation, safety measures, trouble shooting, and preventive maintenance procedures

UNIT II- INFUSION DEVICES (9 hours)

Infusion pump: Principle, types, open and closed loop system, block diagram, description and functions of basic components- Implantable infusion pump, Functional use- Drop rate counter type infusion pump - Functional user-Programmable volumetric infusion pump – Principle working, Functional use-Programmed controlled insulin- Dosing device – Patient preparation for IV Infusion-

Trouble- shooting- Preventive maintenance procedures- Infusion pump analyzer- Syringe infusion pumps: Principle, block diagram, function of control panels, features, fault indication, alarms interpretation, trouble shooting, preventive maintenance procedures - Infusion pump analyzer.

UNIT III- PHYSIOTHERPY EQUIPMENTS (9 hours)

Physiotherapy equipment: Block diagram, operation principle, applications- Short wave diathermy-Microwave diathermy- Ultrasonic therapy unit- Transcutanueous electrical nerve stimulation (TENS) mode- Interferential therapy unit- Traction device- Nerve simulator- Maintenance-trouble shooting of non working unit- Preventive maintenance procedures.

UNIT IV-SURGICAL OF OPERATION THEATER EQUIPMENTS (9 hours)

Electrosurgical units, Warmer (blood and patient) - tourniquet, insufflators, irrigation unit - Operating microscope - arthroscopic, O. T lights, O.T. tables - Flow meters (gas & blood), sterilizing units (auto clave), Surgical driller- Sterilizing producers, manifold unit – Central supply of air.

UNIT V-SURGICAL SCOPY AND SURGICAL DIATHERMY UNIT (9 hours)

Components of endoscope-functional use of each component-development of video scope, Laparoscope, Gastro scope- light sources. Bronchoscope - Video processors, Camera, Fiber optic cable. Depth of penetration and physiological effects of H.F.radiation- short wave- Ultra sonics and microwave diathermy-surgical diathermy, physiological effects of stimulation, Galvanic, Faradic and surged types, interferential therapy.

REFERENCES

1. Albert M.Cook and Webster.J.G. *"Therapeutic Medical Devices",* Prentice Hall Inc., New Jersey, 1982.
2. L.A. Geoddes and L.E. Baker, "*Principles of Applied Biomedical Instrumentation",* John Wiley, 1975.
3. R.S. Khandpur, *"Hand-book of Biomedical Instrumentation*", TMH, Second Ed., 2003.
4. Leslie Cromwell, "*Biomedical Instrumentation and measurement*", Prentice hall of India, New Delhi, 1997.
5. John G. Webster, *"Medical Instrumentation, Application and Design*" John Wiley, Third Ed., 1998.
6. John G. Webster, John W.Calrk, *"Medical Instrumentation, Application and Design"* Fourth Ed., 2010.

7. Mary Dana Gardinder *"Physio Therapy"* R.hale.2008
8. Pushpal Kumar Mitra *"Hand book of practical physiotherapy equipment",* Jaypee Brothers Medical Publisher, 2008

BM2115	BIOMEDICAL MICRO DEVICES	L	T	P	C
	Total contact hours – 45	3	0	0	3
	Prerequisite				
	Nil				

PURPOSE	
To enable the students to acquire knowledge about the principles & application of Biomedical Micro Devices	
INSTRUCTIONAL OBJECTIVES	
1.	To understand the working principle of MEMS & microsystems
2.	To get an idea about what all materials are used in MEMS & Microsystems
3.	To understand the working of MOEMS Technology
4.	To give an insight to the microfluidic systems & biomedical microsystems
5.	To understand the concepts of BioMEMS & its application in healthcare

UNIT I- INTRODUCTION TO MEMS & MICROSYSTEM (9 hours)

MEMS and Microsystems- Introduction - Typical MEMS and microsystem products - Application of microsystem in healthcare industry - Working principles of microsystems- Microsensors (Acoustic wave sensor, Biomedical sensor & biosensor, Chemical sensor, Optical sensor, Pressure sensor, Thermal sensor) – MicroActuation – MEMS with MicroActuation – Micro-accelerators & Micro-fluidics.

UNIT II- MATERIALS FOR MEMS & MICROSYSTEMS (8 hours)

Introduction, Substrates & Wafers, Active Substrate Materials, Silicon as a Substrate Material, Silicon Compounds, Silicon Piezoresistors, Gallium Arsenide, Quartz, Piezoelectric Crystals, Polymers, Packaging Materials, Microsystem Fabrication Processes (Elementary idea)

UNIT III -MICRO-OPTO ELECTRO-MECHANICAL SYSTEM (MOEMS) (9 hours)

Fundamental principle of MOEMS technology - Light modulators, Beam splitter – Micro-lens, Micro-mirrors - Digital micro-mirror device, Light detectors, GLV, Optical Switch, Waveguide & Tuning, Shear-stress measurement.

UNIT IV- MICROFLUIDIC SYSTEMS & BIOMEDICAL MICROSYSTEMS

(10 hours)

Important consideration on micro-scale fluid, Properties of fluid - Fluid actuation methods – Micro-pumps - Typical Micro-fluidic channel, Microfluid Dispenser, Sensing Mechanisms in BCMSSD, Chem- Lab-on-a-Chip, E-Nose, DNA sensors, SAW sensors

UNIT V- BIOMEMS (9 hours)

Introduction to BioMEMS, BioMEMS for Clinical Monitoring - Multi-parameter monitoring - Drug delivery, micro total analysis systems (MicroTAS) detection and measurement methods, Microsystem approaches to polymerase chain reaction (PCR).

REFERENCES

1. Tai-Ran Hsu, '*MEMS & MICROSYSTEMS- Design,Manufacture and Nanoscale Engineering*', John Wiley & Sons, 2nd Edition 2008
2. Nitaigour Premchand Mahalik, '*MEMS*', Tata McGraw Hill, 2nd Reprint 2008
3. Wanjun Wang & Steven A.Soper , '*BioMEMS- Technologies and applications*', CRC Press, 2007
4. Steven S. Saliterman, '*Fundamentals of BioMEMS & Medical Microdevices',* International Society for Optical Engineering, 2006
5. Gerald A Urban, '*BioMEMS',* Springer, 2006
6. Abraham P. Lee and James L. Lee, '*BioMEMS and Biomedical Nanotechnology*', Volume I, Springer, 2006.
7. Paul C.H. Li, '*Introduction to Microfluids and BioMEMS: A Design and Problem-Solving Textbook*', CRC Press, 2009

BM2116	**BIOMEDICAL LASER TECHNOLOGY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Basic knowledge in electronic devices				
PURPOSE					
To gain more knowledge about the various types of LASER used in medicine and how they interact with physiological system.					
INSTRUCTIONAL OBJECTIVES					
1.	To achieve fundamental competency with the use of LASERS in medicine				
2.	To understand the basics concepts of LASER physics				
3.	To learn about different types of Health Care LASER Systems and how they				

	are categorized
4.	Become familiar with the nature of the interaction of LASER radiation and biological tissue
5.	To gain knowledge about the types of LASER used for different medical applications.

UNIT I - BASICS OF LASER (8 hours)

Absorption and Emission of Radiation by atoms, Ions and Molecules, Properties of laser –Mono-chromaticity, Coherence, Directionality, Brightness, Pumping mechanism- Optical pumping, Electrical pumping, Laser pumping, Resonators, Q-switching and its methods, Gain switching, Mode locking and its types, Cavity damping.

UNIT II - LASER FABRICATION (7 hours)

Effect of wavelength, Effect of temperature, Effect of surface films, Effect of angle of incidence, Effect of Materials and Surface Roughness, Refraction, Scattering, Interference, Diffraction, LASER Beam Characteristics, Wavelength, Coherence, Mode and Beam Diameter, Polarization, Focusing with a single lens, Final spot size, Depth of focus, Optical components, Lens doublets, Depolarizers, collimators, Metal optics, Diffractive optical elements - Holographic lenses, Laser scanning system, Fiber delivery system.

UNIT III - TYPES OF LASER (9 hours)

Solid state, Gas, Molecular gas, Semiconductor, Chemical, Free-electron type, X-ray.

UNIT IV - MECHANISM OF LASER TISSUE INTERACTION (9 hours)

Photochemical interaction- biostimulation, Thermal interaction- Heat generation, heat transport, heat effects, LASER induced interstitial thermotherapy (LITT)- Photoabalation: Model, cytotoxicity of UV radiation- Plasma induced ablation: Model, analysis of plasma parameters, photo distribution, plasma formation, shock wave generation, cavitation, and jet formation.

UNIT V - LASERS IN MEDICL DIAGNOSTICS (12 hours)

Photo Dynamic Therapy, LASER in Ophthalmology, Dermatology, Neurosurgery, Dentistry, Gynecology, Urology, Angioplasty and Cardiology, Orthopedics, Gastroenterology, Pulmonology- Other advanced applications of LASER

REFERENCES

1. Markolf H.Niemz, '*Laser Tissue Interaction-Fundamentals and Applications'*, Springer, Third edition, 2007.

2. Orazio Svelto, '*Principles of Laser*', Springer, Fifth edition, 2010.
3. Ronald W.Waynant, '*Lasers in Medicine'*, CRC Press, Second edition,2002
4. G. Reiser, '*Optical fiber communications'*, Tata McGraw Hill, Third Edition, 2000
5. Greory T. Absten, '*Lasers in Medicine: An Introductory Guide'*, Kluwer Academic Publisher, Second edition, 1989.

BM2117	**QUALITY CONTROL AND STANDARDS FOR BIOMEDICAL DEVICES**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Basic knowledge in electronic devices				

PURPOSE	
To impart sufficient knowledge about calibration of devices and importance of quality control in biomedical engineering	
INSTRUCTIONAL OBJECTIVES	
1.	To understand the basics of instrumentation and calibration of instruments.
2.	To understand the concept / principles and various tools available to achieve Total Quality Management
3.	To understand the statistical approach for quality management
4.	To understand various quality tools for efficient management of an organization
5.	To create an awareness about the various certification agencies associated with medical devices

UNIT I - CALIBRATION (9 hours)

Measurement and error, accuracy and precision, sensitivity, resolution, error and error analysis, effect of temperature, friction, stray field, hysteresis, methods of minimizing errors, loading effects. Instrument classification: Active and passive, null and deflection, monitoring and control, analog and digital, absolute and secondary. Methods of measurement: direct & Indirect method, calibration, calibration curve, calibration methodology: direct & indirect comparison.

UNIT II - QUALITY MANAGEMENT PRINCIPLES (9 hours)

Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance appraisal, Benefits,

Continuous process improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic concepts, Strategy, Performance measurement.

UNIT III - STATISTICAL PROCESS CONTROL TOOLS (9 hours)

The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

UNIT IV - QUALITY MANAGEMENT TOOLS (9 hours)

Benchmarking – Reasons and its process- Quality function deployment (QFD) – House of quality, QFD process, Benefits, Taguchi quality loss function, and Total productive maintenance (TPM) – Concept, Improvement needs, FMEA – Stages of FMEA.

UNIT V - STANDARDS FOR MEDICAL DEVICES (9 hours)

Need for standards, ISO 9000:2000 Quality System, FDA, ASTM International, CE, and IEC

REFERENCES

1. Dale H.Besterfield, *'Total Quality Management'*, Third edition, Pearson Education, Third Edition, 2004.
2. Greg Bounds, '*Beyond Total Quality Management-Toward the emerging paradigm'*, McGraw Hill, 2013
3. Shridhara Bhat K, '*Total Quality Management – Text and Cases',* Himalaya Publishing House, First Edition, 2002.
4. Joseph J.Carr, '*Elements of Electronics Instrumentation and Measurement',* Pearson Education, Second Edition, 2003.
5. Alan. S. Morris, '*Principles of Measurements and Instrumentation'*, Prentice Hall of India, Second Edition, 2003.

BM2118	**TROUBLESHOOTING IN MEDICAL INSTRUMENTS**	**L**	**T**	**P**	**C**
	Total contact hours – 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Fundamentals of Circuit Analysis & Electronic Devices are required				

PURPOSE	
To provide knowledge to students to enable them to troubleshoot the various equipments used in hospitals.	
INSTRUCTIONAL OBJECTIVES	
1.	To provide adequate technical information on operating principles of medical instruments to attain mastery in fault detection and corrective measures.
2.	To learn fundamental trouble shooting procedures.
3.	To learn how to test passive & semiconductor.
4.	To be able to drapnoze faults in analog and digital I C S devices
5.	To be able to trouble shoot Biomedical equipments.

UNIT I - FUNDAMENTAL TROUBLESHOOTING PROCEDURES (9 hours)

Making of an Electronic Equipment - causes of Equipment Failure - Troubleshooting Process & Fault finding Aids - Troubleshooting Techniques - Grounding Systems in Electronic Equipment - Temperature Sensitive Intermittent Problems, and Correction Action to repair the Equipment, Tools & Aids for Servicing & Maintenance

UNIT II - TESTING OF PASSIVE COMPONENTS & SEMICONDUCTOR DEVICES (10 hours)

Different types of resistors - Capacitors, Inductors and their testing procedures - Types of Semiconductor & its causes of failure - testing procedure for semiconductor devices - special diodes, Bipolar Transistors, Field effect transistor (FET), Thyristors, IGBT

UNIT III - FAULT DIAGNOSIS IN ANALOG & DIGITAL INTEGRATED CIRCUITS (8 hours)

Characteristics of Op-Amps - Typical Op-Amp Medical Circuits - Fault Diagnosis in Op-Amp Circuits, Digital Troubleshooting Methods - Digital IC Troubleshooters - Circuit board Troubleshooting - Transducers Troubleshooting.

UNIT IV- BIOMEDICAL EQUIPMENT TROUBLESHOOTING –I (8 hours)

Trouble shooting - ECG Machine, EEG Machine, Defibrillator Electrosurgical Unit, Anaesthesia Machine, Autoclaves & sterilizers, Endoscopes.

UNIT V- BIOMEDICAL EQUIPMENT TROUBLESHOOTING –II (10 hours)

Troubleshooting - Incubators, Nebulizer, Oxygen concentrators, Oxygen cylinders & flowmeters, Pulse oximeter, Sphygmomanometers, Suction Machine, X-Ray machine & Ultrasound machine, Preventive maintenance of medical equipments

REFERENCES

1. R S Khandpur, '*Troubleshooting Electronic Equipment- Includes Repair & Maintenance'*, Tata McGraw-Hill, Second Edition 2009
2. Dan Tomal & Neal Widmer, '*Electronic Troubleshooting',* McGraw Hill, 3rd Edition 2004
3. Nicholas Cram & Selby Holder, '*Basic Electronic Troubleshooting for Biomedical Technicians'*, TSTC Publishing, 2nd Edition 2010
4. World Health Organization, '*Maintenance & Repair of Laboratory, Diagnostic imaging & Hospital Equipment'*, Geneva,1994
5. Ian R McClelland , '*X-ray Equipment maintenance & repairs workbook for Radiographers & Radiological Technologists*', World Health Organization, Geneva, 2004
6. Ministry of Health & Family Welfare, '*Medical Equipment Maintenance Manual- A first line maintenance guide for end users'*, New Delhi, October 2010
7. Joseph J Panichello, '*X-Ray Repair : A Comprehensive Guide to the Installation & Servicing of Radiographic Equipment'*, Charles C Thomas Publisher Ltd, 2nd Edition 2005

D) BIOMEDICAL ENTREPRENEURS

BM2119	**BASICS OF MEDICAL ELECTRONICS**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Knowledge in Electronic devices is required				

PURPOSE	
The purpose of this course is to introduce the electronic devices and its application in the field of Biomedical Engineering	
INSTRUCTIONAL OBJECTIVES	
1.	To study the power supply requirements for medical devices
2.	To get familiar with the data gathering and interferences
3.	To get an insight to the interfacing domain
4.	To introduce the sensors for various medical applications
5.	To study the role of electronics in imaging techniques

UNIT I - SEMICONDUCTOR DEVICES **(9 Hours)**

Review of semi conductor Physics, P-N diode and its applications,, Volt-ampere characteristics of P-N diode, Temperature dependence of VI characteristic, Breakdown mechanisms in semi-conductor (Avalanche and Zener breakdown) Diodes, Zener diode characteristics, Varactar diode, LED, optoelectronic devices-Photodiode, phototransistor, opto-coupler

UNIT II - TRANSISTOR **(9 Hours)**

BJT-construction, working, current components and configuration, JFET: construction, working, characteristics, and types.

UNIT III - MOSFET **(9 Hours)**

MOSFET: construction, working, characteristics, and types. MOSFET as a inverter, switch and MOS capacitor.

UNIT IV - THYRISTORS **(9 Hours)**

SCR &TRIAC: construction, working, and characteristics, turn off and turn on methods of SCR, applications of SCR and TRIAC.

UNIT V - CMOS **(9 Hours)**

CMOS: construction, working, characteristics, CMOS as a switch, inverter and optical sensor, advantages compared to other semiconductor devices

REFERENCES

1. J.Millman, C.C.Halkias, and Satyabratha Jit, "*Electronic Devices and Circuits*", Tata McGraw Hill, 2nd edition, 2007.
2. R.L. Boylestad and Louis Nashelsky, "*Electronic Devices and Circuits*", Pearson Prentice Hall, 9th Edition, 2006.

BM2120	**HEALTH CARE AND HOSPITAL MANAGEMENT**	**L**	**T**	**P**	**C**
	Total contact hours – 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				
PURPOSE					
To import adequate knowledge about health care organization system.					
INSTRUCTIONAL OBJECTIVES					

1.	T o study the basics of health care and leadership quality
2.	T o Provide the basic knowledge of management and organization.
3.	To study the various information technology used in health care and strategic planning.
4.	T o provide the basic knowledge of hospital management system.
5.	To know about hospital material, waste, record management.

UNIT I- INTRODUCTION TO HEALTH CARE MANAGEMENT (9 hours)

Overview of health care Management: Management definition-Function and competence-Management position control in the organization Hierarchy-Focus of management- Role of manager in ensuring high performance- Role of manager in successive planning- Role of manager in health care policy-Leadership: Leadership vs Management, Followership- Contemporary model- Leadership style- Leadership competencies- Leadership protocol- Ethical responsibility.

UNIT II- MANAGEMENT AND ORGANIZATIONAL BEHAVIOUR (9 hours)

Management and Motivation: Motivation vs. Engaged-Motivation concept- History of Motivation- Theories of Motivation- Misconception about Motivation and Employee satisfaction- Motivational strategies- Motivation across generation-Organization behavior and management thinking: Field of organization Behavior- Organization behavior contribution to management- Organization behavior issues in Health Organization-Managing and learning.

UNIT III–INFORMATION TECHNOLOGY AND STRATEGIC PLANNING (9 hours)

Information Technology: Information system used by Manager-Electronic Medical Record (EMR) - Challenges to Clinical system Adoption-Future of Healthcare Information Technology on Healthcare manager-Strategic Planning: Planning process- SWOT Analysis- Strategy identification and selection- Rollout and implementation-Strategy execution

UNIT IV –HOSPITAL MANAGEMENT (9 hours)

Evolution and classification of hospital: Classification of hospital-According to directory of hospital-According to ownership and control- According to system of medicine- According to bed strength-According to clinical basis-Hospital as system: Definition of system- Function of hospital-hospital organization- Role of hospital as primary health care- Evolution of hospital administration-Medical staff and hospital organization- Professional service department in hospital organization.

UNIT V–MANAGEMENT OF HOSPITAL MATERIALS AND MEDICAL RECORDS

(9 hours)

Material and waste management-Source of supply-Purchase –Documentation-Packaging and labeling-Management of medical record-Purpose of medical record-Development and content of hospital medical record-Administrative data-Clinical data-Source oriented medical Record-Problem oriented medical Record-Role of medical record professional-Computerization of medical record, Waste management.

REFERENCES

1. Sharon B Buchbindu & Nancy H Shanks, "*Introduction To Healthcare Management*", Jones & Bartlett publisher, 2st edition ,2007
2. A.K.Malhotra, *"Hospital management An Evaluation",* Global India Publication PVT LTD New Delhi, 1st edition, 2009.
3. Stephen.M.Shortell, Arnold.D.Kaluzny, "*Essential Of Healthcare Management"* , William Brottmiller, 1st edition, 1997.
4. Mohammad Akbar Ali Khan, "*Hospital Management",* APH Publishing Corporation, 1st edition, 1999.

BM2121	**INTRODUCTION TO MEDICAL PRODUCT REGULATION**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				
PURPOSE					
To understand the implication of medical product regulation					
INSTRUCTIONAL OBJECTIVES					
1.	To gain knowledge on basic medical product procurement				
2.	To understand medical device safety				
3.	To understand the nature of global issues.				
4.	To learn about standards and certifications				
5.	To understand biostatistics and testing techniques				

UNIT I – CLASSIFICATION OF MEDICAL DEVICE **(9 hours)**

Medical device safety and risk management , Effectiveness/performance of medical devices, Phases in the life span of a medical device , Participants in ensuring the safety of medical devices , The role of each participant/stakeholder , Shared responsibility for medical device safety and performance,

UNIT II – MEDICAL DEVICES REGULATORY FRAME WORK (9 hours)

Introduction, CDRH, Total product life cycle approach, Legislation and FDA Device Law, regulatory considerations for introducing a medical devices to market, Regulatory considerations to market and keep devices in distribution.

UNIT III – CLINICAL TRIALS AND GLPS (9 hours)

Clinical trial design, informed consent, institutional review boards, Investigational device exceptions, purpose of IDE regulation, Bioresearch monitoring, importing and exporting medical devices for investigation and commercial distribution, good laboratory practices.

UNIT IV- REGULATORY BODIES FOR MEDICAL DEVICES (9 hours)

Standard: Definition, and need- Voluntary and mandatory standard- Identification of standards- BIS, FDA, OSHA- WHO's medical device regulation

UNIT V- BIOSTATISTICS & TESTING (9 hours)

Biostatistics-definition-introduction, Statistical Techniques for process Validation & Design Verification, Medical Packaging and Validation, Biocompatibility, Biomedical Engineering from a patient's perspective.

REFERENCES

1. Jonathan S. Kahan (Author), Rachel Meyers (Editor), "*Medical Device Development: Regulation and Law*", 2nd Edition, Parexel, 2009
2. Theodore R. Kucklick, "*The Medical Device R&D Handbook*", Second Edition, Taylor & Francis, 2006
3. John J. Tobin, Gary Walsh , "*Medical Product Regulatory Affairs:Pharmaceuticals, Diagnostics, Medical Devices*", Wiley -Blackwell, First edition,2008
4. Carl T. Demarco ,"*Medical Device Design and Regulation*", ASQ Quality Press, First edition ,2011
5. World health organization -Geneva " *Medical Device Regulations -Global Overview And Guiding Principles*", First edition,2003

BM2122	**TELEMEDICINE AND E-HEALTH**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE	
To introduce the basic concepts of tele-medical technology and mobile telemedicine.	
INSTRUCTIONAL OBJECTIVES	
1.	To make them understand organs and advances in telemedicine.
2.	To impart knowledge on communication infrastructure of telemedicine.
3.	To provide an in-depth knowledge about data security and standards.
4.	To introduce the basic concepts of tele-radiology.
5.	To brief about various applications in telemedicine.

UNIT I – INTRODUCTION TO TELEMEDICINE (**9 hours)**

Historical perspective and Evolution of telemedicine, Tele health, Tele care, Components of telemedicine system, Global and Indian scenario, Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Law governing telemedicine.

UNIT II -TELEMEDICAL TECHNOLOGY (9 hours)

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, Integration and operational issues, Communication infrastructure for telemedicine – LAN and WAN technology, Satellite communication - Mobile hand held devices and mobile communication - Internet technology, Video and audio conferencing - Clinical data –local and centralized.

UNIT III - TELEMEDICAL STANDARDS (9 hours)

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 based PSTN), Video conferencing, Real-time telemedicine integrating doctors / hospitals, clinical laboratory data, radiological data, and other clinically significant biomedical data, Administration of centralized medical data, security and confidentially of medical records and access control, Cyber laws related to telemedicine.

UNIT IV- MOBILE TELEMEDICINE (9 hours)

Tele radiology: Definition, Components of tele-radiology 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, Medical information storage and management for

telemedicine- patient information medical history, test reports, medical images diagnosis and treatment. Hospital information system - Doctors, paramedics, facilities available. Pharmaceutical information system.

UNIT V -TELEMEDICAL APPLICATIONS (9 hours)

Telemedicine access to health care services – health education and self care. Introduction to robotics surgery, tele-surgery. Tele-cardiology, Telemedicine in neurosciences, Electronic Documentation, e-health services security and interoperability., Telemedicine access to health care services – health education and self care, Business aspects - Project planning, Usage of telemedicine.

REFERENCES

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

BM2123	**MEDICAL ETHICS**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE	
The course will explore the major ethical issues confronting the practices of medicine and biomedical sciences	
INSTRUCTIONAL OBJECTIVES	
1.	To gain knowledge on basic human values
2.	To understand how to take responsibility for morals and mistakes
4.	To understand the role of engineers in decision making.
5.	To develop aptitude to understand law and problems relevant to it
6.	To get familiar of ethical issues in medicine, health care and life science

UNIT I-HUMAN VALUES AND ENGINEERS (9 hours)

Morals- Values and Ethics – Integrity – Work Ethic – Service Learning –Respect for Others – Living Peacefully ,Caring , Sharing , Honesty , Courage ,Valuing Time , Co-operation – Commitment – Empathy – Self-Confidence – Character –Spirituality, Engineers as responsible experimenters

UNIT II - SAFETY- RESPONSIBILITIES AND RIGHTS (9 hours)

Safety and risk: Assessment, risk benefit analysis and reducing risk- the three mile island and Chernobyl case studies- Collegiality and loyalty- respect for authority-collective bargaining- confidentiality - conflicts of interest - occupational crime-professional rights- Employee rights- Intellectual property rights (IPR)- discrimination

UNIT III - GLOBAL ISSUES (9 hours)

Multinational corporations - Environmental ethics - computer ethics – ethics on internet - engineers as managers-consulting engineers-engineers as expert witnesses and advisors -moral leadership-sample code of Ethics like ASME- ASCE- IEEE- Institution of engineers (IEI) India- Institution of Electronics and Telecommunication engineers (IETE) India-etc

UNIT IV – BIOETHICS – I (9 hours)

Artificial Reproductive Technologies, Abortion, Prenatal diagnosis, End of life issues, Duties towards life, Principle of double effect reasoning, Physician assisted suicide, Cloning, Protecting future generations

UNIT V- BIOETHICS – II (9 hours)

Human dignity and human rights – Benefit and harm, Autonomy and individual responsibility, Persons without the capacity to consent, Privacy and confidentiality, Equality, justice and equity, Non-discrimination and non-stigmatization, Respect for cultural diversity and pluralism, Social responsibility and health, Protection of the environment, the biosphere and biodiversity

REFERENCES

1. Govindarajan M- Natarajan S- Senthil Kumar V- S- "*Engineering Ethics",* Prentice Hall of India- New Delhi- 2004.
2. R.S Nagarazan -*"A textbook on Professional Ethics and Human Values*" New Age International Publishers- New Delhi 2006.
3. Charles D- Fleddermann, *"Engineering Ethics",* Pearson Education / Prentice Hall, New Jersey- 2004 (Indian Reprint).

4. Mike Martin and Roland Schinzinger- *"Ethics in Engineering*"- Tata McGraw-Hill- 996-3 e.
5. Jon W Gordon *"The Science And Ethics Of Engineering The Human Germ Line Mendel's Maze",* John Wiley Publication, 2003
6. Charles M Culver , K Danner Clouser, Bernard Gert, *"Bioethics.: A Return to Fundamentals"* - John Wiley Publication, 2003
7. Thomas A. Shannon and Nicholas J. Kockler, "*An Introduction to Identify ethical issues in medicine, health care and life science*",2004
8. UNESCO Universal Declaration on Bioethics and Human Rights
9. S. Ignacimuthu, "*Bio-ethics"*, Alpha Science International Ltd., 2009
10. Justin Oakey, "*Biethics"*, 2009.

E) RESEARCH AND DEVELOPMENT BIOMEDICAL ENGINEER

BM2124	**BIOMATERIALS FOR THE DESIGN OF MEDICAL DEVICES**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE	
To understand the principles and biology underlying the design of implants and artificial organs.	
INSTRUCTIONAL OBJECTIVES	
1.	To gain knowledge about the classes of biomaterials used in medicine and specific requirements.
2.	To Understand the concept of biocompatibility and the methods for biomaterials testing.
3.	To Understand the fundamental principles in biomedical engineering, material science and chemistry, and how they contribute to biomaterial development and performance.
4.	Apply maths, science, and engineering knowledge gained in the course to biomaterial selection and design.
5.	To gain Knowledge about the practical aspects of biomedical devices: sterilization, manufacturing.

UNIT I - INTRODUCTION TO BIOMATERIALS (9 hours)

Definition of biomaterials, Structure of solids, Characterization of materials-Electrical property-Mechanical property-Optical property-X-ray absorption-Acoustic and ultrasonic property-Density and porosity-Diffusion property-Sterilization. Classification of biomaterials-implant design requirements.

UNIT II – METALS (9 hours)

Types of metals and their applications- Stainless steel-classification, Cobalt based alloys-types-Titanium based alloys- Hard tissue replacements, Comparison of orthopedic implant materials, Composites as biomaterials.

UNIT III – POLYMERIC AND CERAMIC MATERIALS (9 hours)

Ceramic: Nearly inert-porous, resorbable, carbon base implant materials. Polymers: Mechanical and thermal properties, Polyesters, Polyacrylates, Polyanhyrides - Biodegradable polymers – Hydrogels – Elastomer – Dendrimers. Soft tissue replacement- Sutures, surgical tapes, skin implants.

UNIT IV – ACTIVE AND NANO MATERIALS (9 hours)

Significance of active materials-shape memory alloys, and polymers-electroactive polymers as actuators and sensors, pyroelectric, hydroactive, photoactive materials, active ceramics. Nanomaterial for bone, bladder, neural, cartilage, vascular applications.

UNIT V - OTHER APPLICATIONS AND BIOCOMPATIBILITY (9 hours)

Dental implants –Cardiovascular devices- Maxillofacial devices. Tissue response to implants, Body response to implants, Carcinogenicity, Wound healing and Foreign body response Failure mechanisms; corrosion, fracture, degradation of Implanted Materials – Polymers, metals, ceramics.

REFERENCES

1. Joseph R. Davis, "*Handbook of Materials for Medical Devices*", ASM International, 2003.
2. Andrés Díaz Lantada, "H*andbook of Active Materials for Medical DevicesAdvances and Applications*", CRC Press, 2011.
3. Zoraida Aguilar, "Nanomaterials for Medical Applications" , Newnes, 2012
4. Joonpark, R.S.lakes, "*Biomaterials and introduction*", 3rd edition, Springer Science Business Media LLC, 2007.

5. Lisa A.Pruitt and Ayyana M chakravartula, "*Mechanics of biomaterials-Fundamental principles of implant design*", University Press, Cambridge, 1st edition, 2011.
6. Ratner, Hoffman, Schoet and Lemons, *"Biomaterials Science: An introduction to Materials in Medicine*", Elsevier Academic Press, 2nd edition, 2012.

BM2125	**ADVANCES IN REHABILITATION ENGINEERING**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE

To inform biomedical engineers and technologists about the rehabilitation devices available today, their important background information and give professionals a method for seeing where these devices fit into the spectrum of assistive technology.

INSTRUCTIONAL OBJECTIVES

1.	To understand the biomechanics of mobility and universal design
2.	To learn about personal transportation, manual and powered wheelchairs
3.	To follow the working of prosthetics, orthotics and rehabilitation robotics
4.	To understand sensorial prostheses
5.	To perceive the idea of rehabilitation medicine and advocacy

UNIT I - INTRODUCTION, BIOMECHANICS OF MOBILITY AND UNIVERSAL DESIGN (9 hours)

Rehabilitation Engineering and assistive technology: Design, considerations, concepts and terminologies– Approaches to rehabilitation: Biomechanics of mobility and universal design -Gait analysis-Biomechanics of wheel chair propulsion-Barrier free design- design for people with disabilities

UNIT II – PERSONAL TRANSPORTATION, MANUAL AND POWERED WHEELCHAIRS (9 hours)

Personal transportation - Lift mechanisms –Wheel chair safety, standards, testing. Manual and Powered wheel chairs -Design and components-Materials-Wheels and casters-human factors-Power wheel chair classes-Motor selection-Batteries-Microprocessor and fault tolerant control.

UNIT III – PROSTHETICS, ORTHOTICS AND REHABILAITATION ROBOTICS

(10 hours)

Prosthetics: Introduction, upper, lower and external, internal prosthetics- Orthotics: Functional electrical stimulation (FES), ambulatory aids, aids for daily living, prosthetics using myo-electric signal control- Rehabilitation robotics: Introduction, configuration and its components, control and sensors

UNIT IV - SENSORIAL PROSTHESES **(9 hours)**

Engineering concepts in sensory rehabilitation engineering-Sensory augmentation and substitution-Retinal prostheses-Intelligent techniques in hearing rehabilitation-tactual sensory substitution-artificial larynx

UNIT V - REHABILITATION MEDICINE AND ADVOCACY **(8 hours)**

Rehabilitation team-Organization of services-Disability assessment-behavioral disorders-Psychiatric problems and rehabilitation- Legal aspects and provisions available

REFERENCES

1. Rory.A.Cooper, '*Rehabilitation Engineering Applied to Mobility and Manipulation*', First Edition, CRC Press, 2010
2. Horia-Nicolai.L.Teodorescu, Lakhmi C. Jain, *'Intelligent Systems and Technologies in Rehabilitation Engineering'*, First Edition, CRC press, 2010
3. Glenn Hedman, '*Rehabilitation Technology',* First Edition, Haworth Press Inc, 1990
4. Michael P. Barnes, Anthony B. Ward, '*Oxford Handbook of Rehabilitation Medicine'*, First Edition, Oxford University Press, 2005

BM2126	**NEURAL ENGINEERING AND MODELING**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				
PURPOSE					
To provide knowledge about the fundamentals of neurophysiology in neuronal modeling and its application to neural imaging and neuro-prosthetic devices					
INSTRUCTIONAL OBJECTIVES					

1.	To understand the basics functions of neuron and nervous system
2.	To study the process of neurotransmission and various types of neurotransmitters
3.	To gain knowledge about the different neuro-prosthetic devices.
4.	To understand the concepts of different neural imaging techniques
5.	To study the different types of neuron models

UNIT I - INTRODUCTION TO NEURONS AND NERVOUS SYSTEMS (12 hours)

Structure and function of neurons - types of neurons - Synapses - Glial cells - myelination - Neuronal differentiation - Characterization of neuronal cells -Central and peripheral nervous systems- Blood Brain barrier -Meninges and Cerebrospinal fluid- Neuron membrane potential

UNIT II – NEURO-TRANSMISSION AND NEURO-TRANSMITTERS (8 hours)

Neurotransmission-stages in neurotransmission- synaptic transmission-chemical and electrical synaptic transmission- neurotransmitters and their release-types of neurotransmitters-fast and slow neurotransmission

UNIT III – NEURO-PROSTHETICS (9 hours)

Sensory prosthetics-visual prosthetics-Bionic eye-retinal prosthetic-auditory prosthetics-cochlear implant-Auditory brain stem implant- bionic ear- spinal cord stimulator- Motor prosthetics- bladder control implant-sacral anterior root stimulator-prosthetics for conscious control of movements-Brain computer interface

UNIT IV – NEURAL IMAGING TECHNIQUES (9 hours)

Functional Magnetic Resonance Imaging (fMRI)- Magnetic resonanace imaging (MRI)- Positron emission tomography (PET) - Electroencephalography (EEG)- Computerized axial tomography (CAT) scans in brain imaging

UNIT V – NEURAL MODELLING (7 hours)

Single neuron-biophysical non linear models-Hodgkin-Huxley neuron model, Fitzhugh Nagumo models-Morris lecar model-Hind marsh rose model-simple models of point neurons

REFERENCES

1. Metin Akay "*Handbook of Neural Engineering",* First edition ,Wiley –IEEE press,2007
2. Bin He "*Neural Engineering",* First edition, Springer 2005

3. Koch Chrisof Segev,Idan "*Methods In Neuronal Modelling:From Ions To Networks"*, Second Edition, MIT Press, 1999
4. Fitzhugh. R,Izhikevich.E, "*Fitzhugh–Nagumo model",* Scholarpedia,1(9):1349, doi:10.4249/scholarpedia, 1349, 2006
5. Warren E.Finn, Peter G.Lopresti, "*Handbook of Neuroprosthetic methods"* CRC press, Baco Raton Florida, 2003.

BM2127	ERGONOMICS	L	T	P	C
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE

To provide the ability to solve day to day work problem by safe and efficient means.

INSTRUCTIONAL OBJECTIVES

1.	To understand the basics of Biomechanical, physiological and anthropometric background.
2.	To impart the knowledge about the user information, controls, relationship between information and operation.
3.	To gain a deep knowledge about the different guidelines related to environmental factors.
4.	To understand the design factors for health, safety and comfort
5.	To Study ergonomics in healthcare.

UNIT I – HUMAN- ENVIRONMENT INTERACTION (8 hours)

Biomechanical, Physiological, Anthropometric background - Posture - Sitting, Standing - Change of posture - Hand and arm postures - Movement – Lifting, carrying, pulling and pushing.

UNIT II – INFORMATION AND OPERATION (8 hours)

The user Information - Visual information, Characters, Diagrams - Perception of visual information - Hearing - Other senses - Controls - Distinguishing between controls - Types of controls - Relationship between information and operation – Expectation - User-friendliness - Different forms of dialogue - Help

UNIT III – ENVIRONMENTAL FACTORS (9 hours)

Noise: It's guidelines, noise reduction at source, noise reduction through workplace design and work organization, and hearing conservation – Vibration: It's guidelines,

and preventing vibration – Illumination: Guidelines on light intensity, brightness differences, improved lighting; Climate: Guidelines on thermal comfort, heat and cold, and Climate control - Chemical substances: It's guidelines, and measures taken at source – Ventilation: Measures at the individual level.

UNIT IV– HEALTH, SAFETY AND COMFORT FACTORS (11 hours)

Occupational health & safety management - Human error and human reliability – Analysis - Managing low-back disorder - Risk in the workplace - Work-related upper extremity musculoskeletal disorders.

UNIT V– HUMAN FACTORS AND ERGONOMICS (9 hours)

Standards- Applications in healthcare – Neuro-ergonomics in human-system interaction.

REFERENCES

1. Gavriel Salvendy, '*Handbook of Human Factors and Ergonomics*', John Wiley & Sons, Fourth Edition 2012.
2. R.S. Bridger, Hants, "*Introduction to Ergonomics",* CRC Press, Third edition, 2008.
3. Jan Dul & Bernard Weerdmeester, "*Ergonomics for beginners*", CRC Press, Second edition, 2001.
4. Martin Helander, "*A Guide to Human Factors and Ergonomics"*, CRC Press, Second edition, 2006.
5. K.H.E. Kroemer, E. Grandjean, "*Fitting the Task to the Human - A Text book of Occupational Ergonomics*", CRC Press, Fifth edition, 1997.

BM2128	**ADVANCED NEURAL NETWORKS AND GENETIC ALGORITHMS**	**L**	**T**	**P**	**C**
	Total Contact Hours -45	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE	
To learn the basic concepts of neural networks & genetic algorithm and their biomedical applications	
INSTRUCTIONAL OBJECTIVES	
1.	To understand the basic concepts of artificial neural network (ANN)
2.	To study the various ANN Models

3.	To familiarize about the principle component analysis and self organizing map
4.	To study the basic concepts of genetic algorithm
5.	To apply the concepts of ANN in biomedical applications

UNIT I - ARTIFICIAL NEURAL NETWORKS (ANN)-AN OVERVIEW (9 hours)

Biological Neurons and their Artificial models, Neuron model – single input neuron – activation function – multiple input neuron, Neural Network Learning Rules, Hebbian learning-competitive learning, supervised and unsupervised learning , Single Layer Perceptron Classifiers, Perceptron convergence theorem, delta rule.

UNIT II - ARTIFICIAL NEURAL NETWORKS (ANN) MODELS (9 hours)

Back Propagation Network, Generalised Delta Rule, BPN Application, Associative Memory definition, BAM, Hopfield Memory, Simulated Annealing – Boltzmann Machine. Hopfield -Travelling salesman problem, Adaline net, Madaline net.

UNIT III - PRINCIPAL COMPONENT ANALYSIS (PCA) AND SELF ORGANIZATION (9 hours)

Principle component analysis (PCA) -Adaptive PCA using lateral inhibition-Two classes of PCA algorithm-Two basic feature- mapping model- Principle of self organization-self organizing map-SOM Algorithm-properties of the feature map-LVQ-Hierarchical vector quantization. Kohonen self organizing maps- Applications of self-organizing maps- Adaptive resonance theory

UNIT IV – INTRODUCTION TO GENETIC ALGORITHMS AND ITS TECHNIQUES (9 hours)

Robustness of traditional optimization and search methods, goal of optimization, a simple genetic algorithm, Genetic algorithms at work-simulation by hand, data structures, genetic operators – reproduction, crossover and mutation, mapping objective functions to fitness form, fitness scaling, current applications of genetic algorithm.

UNIT V - ADVANCES IN NEURAL NETWORK AND BIOMEDICAL APPLICATIONS (9 hours)

Support vector machine (SVM), Radial basis function network- Neural networks in ECG classifications, ANN in ECG analysis- Recurrent probabilistic neural network for EMG pattern recognition- Applications of neural network in breast cancer detection using ultrasound image.

REFERENCES

1. Laurene Fausett, *"Fundamentals of Neural Networks: Architectures Algorithms"*, and Applications", Pearson/ Prentice Hall, Third edition, 2008.
2. James A Freeman and David M.Skapra, "*Neural Network",* Addison – Wesley, India,Third edition, 2008.
3. Simon Haykin, *"Neural Networks and Learning Machines"* -3/E - Pearson/ Prentice Hall, Third edition, 2009.
4. Robert J Schalkoff, *"Artificial Neural Networks"*, McGraw Hill, Third edition, 2011.
5. David Goldberg, *Genetic Algorithms in Search, Optimization and Machine Learning"*, Pearson Education, Fourth edition, 2009.
6. Melanie Mitchell, *An Introduction to Genetic Algorithms"* Prentice Hall of India, New Delhi, First edition, 1998.
7. Rezaul Begg, Joarder Kamruzzaman, Ruhul Sarter, "*Neural Networks in Health care: Potential and Challenges",* Ideal group publishing USA, 2006.

BM2129	**COMPUTATIONAL FLUID DYNAMICS IN MEDICINE**	**L**	**T**	**P**	**C**
	Total Contact Hours -45	**3**	**0**	**0**	**3**
	Prerequisite				
	Basic knowledge in fluid mechanics & mathematics (PDE, and linear algebra) is required				

PURPOSE	
To enable the students to acquire knowledge about computational fluid dynamics (CFD) which is useful in analysis & design of various fluid flow medical devices	
INSTRUCTIONAL OBJECTIVES	
1.	To understand fundamentals of fluid dynamics
2.	To understand the importance of CFD and numerical methods
3.	To get an insight into finite element method (FEM), finite difference method (FDM) & finite volume method (FVM)
4.	To study the fundamentals of discretization
5.	To know about the application of CFD in biomedical domain

UNIT I - FUNDAMENTALS OF FLUID DYNAMICS (10 hours)

Definition & properties of fluids and classification of fluids, Introduction to fluid statics & kinematics, Governing Equations of fluid motion: Langragian & Eulerian description,

Reynolds transport theorem, Integral & differential forms of governing equations: mass, momentum & energy conservation equations, Euler's Equation, Bernoulli's Equation, Navier-Stokes equations

UNIT II - CFD AND NUMERICAL METHODS (8 hours)

Computational fluid dynamics (CFD)- Significance and Applications- Classification and Overview of numerical methods: Classification into various types of equation; parabolic elliptic and hyperbolic; boundary and initial conditions; over view of numerical methods, Illustrative examples of elliptic, parabolic and hyperbolic equations.

UNIT III – ADVANCE NUMERICAL METHODS (9 hours)

Finite element method (FEM) & its application- Finite difference method (FDM) & its application- Finite volume method (FVM) & its application.

UNIT IV - FUNDAMENTALS OF DISCRETIZATION (10 hours)

Discretization principles: Pre-processing, Solution, Post-processing, Comparison of discretization techniques, Introduction to ABACUS mechanical software, Illustration of Software usage with a Biomedical Example (bone/aorta)- Introduction to MIMICS software (only 3-D Construction part).

UNIT V - CFD IN MEDICINE (8 hours)

Examples of Biomedical CFD applications, Case study-1: Respiratory flow in a bifurcation- Case study-2: CFD analysis of blood pump- Case Study-3: Computational model of blood flow in the aorta-coronary bypass graft.

REFERENCES

1. Robert W. Fox, Philip J. Pritchard, Alan T McDonald, '*Introduction to Fluid Mechanics*', John Wiley & Sons, Seventh Edition 2009.
2. Frank M. White, '*Fluid Mechanics*', Tata McGraw-Hill, Singapore, Sixth Edition, 2008
3. Goldstein J. Richard, '*Fluid Mechanics Measurements'*, Taylor & Francis Publication, Second Edition 1996
4. T.J. Chung, '*Computational Fluid Dynamics',* Cambridge University Press, 2nd Edition 2010
5. John D. Anderson, Jr, '*Computational Fluid Dynamics The Basics with Applications',* Tata Mcgraw Hill, 2012
6. J.Blazek, '*Computational Fluid Dynamics: Principles & Applications',* Elsevier, 1st Edition 2001

7. J.H. Ferziger & M. Peric, '*Computational Methods for Fluid Dynamics', Springer,* 3rd Edition 2002
8. Versteeg H.k & Malalasekara W, *'Introduction to Computational Fluid Dynamics: The Finite Volume Method',* Pearson Education, 2nd Edition 2008
9. C.T. Shaw, '*Using Computational Fluid Dynamics',* Prentice Hall 1992
10. S.S. Quek & G.R. Liu, *'Finite Element Method: A Practical Course'*, Elsevier Science, 1st Edition 2003

Program Elective From Courses Offered By Faculty Of Management

MB2206	**CUSTOMER RELATIONSHIP MANAGEMENT**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**2**	**2**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE

The course aims to enable the students to understand the concept of Customer Relationship Management (CRM) application in consumer and business markets and technological tools for e-CRM.

INSTRUCTIONAL OBJECTIVES

1.	To Gain an insight into the concept and applications of Customer Relationship Management.
2.	To understand the e-CRM solutions and strategic implementation of CRM.

UNIT I -THE CONCEPT OF CRM (9 hours)

Explosion of CRM in IT marketing - IT enablers of Growth of CRM - Criticality of On site, Off shore Customer Relationship - Adoption and implementation of CRM - conceptual foundations of CRM

UNIT II - CRM APPLICATIONS IN CONSUMER AND IT BUSINESS MARKETS (9 hours)

CRM in IT Outsourcing Industries - Banking , Insurance, Telecom, Hospitality, etc., - CRM in B 2 B IT markets.

UNIT III - TECHNOLOGICAL TOOLS FOR CRM (9hours)

Components of e-CRM solutions - Introduction - Data Warehousing- Data mining - e-CRM -campaign management - IT sales force automation – IT Customer service -

and support - Role of Interactive Technologies – Product offerings in CRM Market space - Call centers of CRM

UNIT IV - CRM IMPLEMENTATION (9hours)

Defining a CRM Strategy - Implementation road map - Developing a relationship orientation - IT Customer centric Marketing and process - building organizational capabilities through Internal Marketing - Issues in Implementing a Technology solution for CRM - Building organizational capabilities - Issues in implementing a technology solution for CRM.

UNIT V - OPERATIONAL ISSUES IN IMPLEMENTING CRM (9 hours)

Process view of CRM - learning from customer defections – IT customer retention plans - evaluating retention programmes – Outsourcing process view of CRM and solutions.

References:

1. G.Shainesh and Jagadish N.Seth, *'CRM A Strategic Perspective'*, Macmillan, 2008
2. Francis Buttle, *'CRM Concepts and Tools',* Elsevier 2009
3. Paul Green Berg, *'CRM at the Speed of Light'*, Tata McGraw-Hill
4. Jill Dyche, *'The CRM Handbook-A Business Guide to Customer Relationship Management*, Pearson Education 2002.
5. Jagadish N Seth et al, *'CRM Emerging Concepts, tools and applications'*, Tata McGraw-Hill.

MB2208	**MARKETING RESEARCH FOR ENGINEERS**	**L**	**T**	**P**	**C**
	Total Contact Hours –45	**2**	**2**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE

The purpose of learning this course is to equip the students with the skills of designing and implementing the marketing research programs across the spectrum of marketing function in order to introspect, perceive, plan & design methodologies, analyze and solve day to day problems of the organization with regard to their marketing function.

INSTRUCTIONAL OBJECTIVES

1.	To learn, comprehend and apply effective marketing research techniques to solve day to day marketing problems.
2.	To develop and implement a marketing research program for providing solution to the managerial decision making function.

UNIT I – INTRODUCTION **(9 hours)**

The Role of Marketing Research- The Marketing Research Process-The Human Side of Marketing Research: Organizational and Ethical Issues.

UNIT II - DESIGNING RESEARCH STUDIES **(9 hours)**

Qualitative Research- Secondary Data Research in a Digital Age – Survey Research-Observation-Conducting Marketing Experiments.

UNIT III – MEASUREMENT **(9 hours)**

Measurement and Attitude Scaling- Questionnaire Design.

UNIT IV - SAMPLING AND STATISTICAL THEORY **(9 hours)**

Sampling Designs and Sampling Procedures- Reviewing Statistical Theory and Determining Sample Size.

UNIT V - ANALYSIS AND REPORTING **(9 hours)**

Basic Data Analysis-Testing for Differences Between Groups and for Relationships among Variables-Communicating Research Results.

REFERENCES

1. G.C. Beri, *'Marketing Research'*, Tata McGraw-Hill Education.
2. Harper W. Boyd Jr, Ralph Westfall, Stanley F. Stasch, Richard D. Irwin Inc.,*'Marketing Research – text and cases'*, All India Traveller Book Seller.
3. Raymond Kent, *'Marketing Research – Measurement, Method and application'*, International Thomson Business Press.
4. William G. Zikmund, Barry J. Babin, '*Essentials of Marketing Research, International Edition, 5e*, Cengage Learning
5. William G. Zikmund, Barry J. Babin, Jon C. Carr, Mitch Griffin, '*Business Research Methods, International Edition*, 9e, Cengage Learning

MB2209	**PSYCHOLOGY AT WORK**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**2**	**2**	**0**	**3**
	Prerequisite				

	Nil				

PURPOSE	
This course is designed to provide an overview of behavioural psychology including individual, group, and organizational issues resulting in enhanced understanding of the world of business and related career concerns.	
INSTRUCTIONAL OBJECTIVES	
1.	Acquaint prospects of behavioural psychology
2.	Understanding role of job analysis in preparation for personnel selection
3.	Enhancing significance of training and development, performance evaluation

UNIT I - INTRODUCTION TO PSYCHOLOGY (**9 hours)**

Definition and Scope of Psychology, Methods of Psychology – Introspection, Observation, Case Study, Interview, Survey and Experimental method - Branches of psychology

UNIT II - INDIVIDUAL DIFFERENCES (**9 hours)**

Heredity and environment - Personality – Nature and Definition - Approaches to Personality - Attention - Span division and distraction. Perception – Perceptual constancy – Illusions, Internal and External factors influencing Perceptual.

UNIT III – MOTIVATION (**9 hours)**

Definition and functions of Motives. Types of Motives – Physiological and Psycho-Social motives - Maslow's theory of Motivation. Learning Definition, Classical and Instrumental Conditioning. Learning by Insight and Observation, Latent learning - Role of Motivation. Reward and Punishment in Learning, Learning curves, efficient methods of learning, Transfer of Learning Psychology

UNIT VI – INTELLIGENCE (**9 hours)**

Concept of IQ, Types of Intelligence tests, Variations in Intellectual ability – Intellectually gifted and retarded, Factors influencing individual differences in intelligence – Heredity and Environment - Emotion – Definition and nature of emotions. Memory - Meaning , Types of memory, Methods of measuring memory, Information Processing model of memory, curve of forgetting and causes of forgetting, Methods of Improving Memory

UNIT V – STRESS (**9 hours)**

Sources of stress and reactions to stress - Coping with stress -. Application of stress management techniques - Socio-cultural factors and behaviour - Development of

attitudes, stereotypes and prejudice, Measurement of Attitudes (Thurstone, Likert attitude scale and Bogardus Social Distance scale) - Strategies for reducing prejudice and changing attitude –Person Health and mental health (Yoga, meditation and relaxation therapies).

REFERENCES

1. Atkinson & Hilgard , Introduction to Psychology , Thomson Wardsworth 14th Edition.
2. Baron, R.A, Psychology, Pearson Education Inc., New Delhi
3. Parameswaran, E.G. and Beena, C, Invitation to Psychology, Neelkamal Publications.
4. Introduction to Psychology, Kuppusamy, Asia Publishing House
5. Social Psychology, Baron and Byrne Tate McGraw Hill
6. Introduction to Social Psychology, Lindgren.

MB2211	CREATIVITY FOR ENGINEERS	L	T	P	C
	Total Contact Hours – 45	2	2	0	3
	Prerequisite				
	Nil				

PURPOSE

This course gives students principles and tools to engage in more right-brain thinking nonverbal, analogical, non-temporal, and holistic. Students will supplement their valuable left-brain abilities with equally valuable right-brain abilities.

INSTRUCTIONAL OBJECTIVES

1.	Creative-innovative approaches to resolving issues.
2.	Identifying and solving problems, seeking and pursuing opportunities, and molding their futures

UNIT I – CREATIVITY (**9 hours)**

Introduction - Making a case for creativity - Creative thinking as a skill - Valuing diversity in thinking - Thinking preferences - Creativity styles - Setting the stage for success - Basic philosophy - Having a vision – Setting the right attitude - Recognizing and avoiding mental blocks – Avoiding mindsets - Risk taking - Paradigm shift and paradigm paralysis

UNIT II - INDIVIDUAL AND TEAM WORK (**9 hours)**

Creativity in problem solving - Problem Definition – Understanding, Representing - Pattern Breaking - Thinking differently - Changing your point of view - Watching for paradigm shift - Challenging conventional wisdom - Lateral thinking, provocation (escape, random word) – Mind stimulation: games, brain-twisters and puzzles

UNIT III - GENERAL STRATEGIES (**9 hours)**

Idea-collection processes - Brainstorming/Brain-writing - The SCAPER methods - Metaphoric thinking - Outrageous thinking - Mapping thoughts - Other (new approaches) - Using Math and Science - Systematic logical thinking - Using math concepts

UNIT IV - EIGHT-DIMENSIONAL (8D) APPROACH TO IDEATION

(**9 hours)**

Uniqueness – Dimensionality – Directionality - Consolidation –Segmentation – Modification – Similarity – Experimentation

UNIT V - INVENTIVE THINKING (**9 hours)**

Systematic Inventive Thinking - Systematic inventive thinking: The TRIZ methodology - Decision and Evaluation - Focused thinking framework – Six thinking hats - PMI - Ethical considerations - Design for Interaction - Introduction to design for interaction - Intellectual Property - Introduction to intellectual property: Patents, Copyrights, Trademarks, Trade Secret, Unfair Competition.

REFERENCES

1. Harry Nystrom, “Creativity and Innovation”, John Wiley & Sons
2. Jacob Solinger, “Apparel Manufacturing Handbook”, Reinhold Publications
3. Brain Twiss, “Managing Technological Innovation”, Pitman Publishing Ltd
4. Harry B. Watton, “New Product Planning”, Prentice Hall Inc

MB2213	**FINANCIAL STATEMENT ANALYSIS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**2**	**2**	**0**	**3**
	Prerequisite				
	Nil				
PURPOSE					
Knowledge of the basic financial position of companies is mandatory for a professional in order to maximize his investment. This course comprises of techniques that are used to evaluate a companies’ financial position.					

INSTRUCTIONAL OBJECTIVES	
1.	To enable students asses the past and current position of the company.
2.	To predict profitability and growth prospects of a given company.

UNIT I- INTRODUCTION (9 hours)

Overview of Business Activities-Basic concepts underlying financial accounting-Various financial statements.

UNIT II - FINANCIAL STATEMENTS (9 hours)

Balance sheet and related concepts – Profit & Loss Statement and related concepts.

UNITIII- FINANCIAL STATEMENT ANALYSIS-PART 1 (9 hours)

Financial Ratio Analysis – Cash flow analysis – Funds flow analysis – Comparative financial statements –Comparative Analysis –Common size Analysis-Trend Analysis Dupont Analysis.

UNITIV- FINANCIAL STATEMENT ANALYSIS-PART 2 (9 hours)

Analysis & Interpretation of financial statements of Various Companies-Industry Analysis- Manufacturing-Pharma-Banking- Telecommunication-Insurance-Aviation.

UNITV-ISSUES AND GUIDELINES (9 hours)

Problems in Financial Statement Analysis –Guidelines in Financial Statement Analysis.

REFERENCES

1. M.Y.Khan and Jain – Management Accounting, Tata McGraw Hill Publishing Co Ltd.,
2. S.N.Maheswari – Management Accounting, Sultan Chand & Sons, New Delhi

MB2215	RISK MANAGEMENT SYSTEMS	L	T	P	C
	Total Contact Hours – 45	2	2	0	3
	Prerequisite				
	Nil				

PURPOSE
To identify potential problems before they occur so that risk-handling activities may be planned and invoked as needed.

INSTRUCTIONAL OBJECTIVES	
1.	To enable the students evaluate the exposure that each enterprise is having to risk.
2.	To assess risk and to develop strategies to minimize them.

UNIT I – INTRODUCTION (**9 hours)**

Risk- Uncertainty- Peril- Hazard- Classification - cost risk—Meanin - Scope & Objective of Risk Management- Personal risk management- Corporate risk management-Risk Management Process- Administration of Risk Management Process- influencing factors- constrains-monitoring & review-Risk Identification- Perception of risk- Operative cause/perils- Safety Audit- Risk Evaluation - Presentation of Data- Probability Concepts- Risk and Law of large number-Risk Control-Risk avoidance- Risk reduction- Classifications- Evaluation of risk reduction measures- Risk Financing- Retention-Determination of retention levels- Captive Insurer- Self Insurance- Risk retention group. Transfer- Non-insurance transfer- Insurance.

UNIT II-ENTERPRISE RISK MANAGEMENT (**9 hours)**

Meaning – Pro c e s s – fu n c t io ns - Prerequisite for ERM - Credit Risk Management: Need, Securitization for credit risk, Credit derivatives, Methods- Operational Risk Management- Importance, Measurement of Operational risk, Stages -Strategic Risk Management: Strategic out look to risk management, Strategic planning to manage risk -Managing risk in Merger & Acquisitions.

NIT III - PROJECT RISK MANAGEMENT (**9 hours)**

Meaning -Source & Classification - Cost & Effect Reason -Scope- Objective -Phases - Prerequisite of risk response- Characteristics of - Type of risk handling Strategies- Factors - Insurance & Project Risk Management- Risk management in different types of project- Operational Risk Management: Meaning - Sources - Operational Events- Regulatory issues -Objective- Stages - Roles of Supervisor- Disclosure Requirement- Insurance & Operational Risk Management.

UNIT IV-FINANCIAL RISK MANAGEMENT (**9 hours)**

Definition - Source - Need & Importance- Tools - Derivatives- Futures- Swaps- Options- Role of Chief Risk Officer- Integrated Risk Program

UNIT V - TREASURY RISK MANAGEMENT (**9 hours)**

Money market- Trends in Security Market- Trends in Interest Rates- EFinance- Integrated treasury in Public Sector Banks- Volatility trading- Floating-Capital

Adequacy- Liquidity Management-Tools: Currency future- Financial future- Commodity future- Steel future- Options , Real Options- Weather derivatives Insurance.

REFERENCES

1. Principles of Risk Management & Insurance – George E. Rejda.
2. Risk Management & Insurance- Scott Harington.
3. Risk Management & Insurance- C. Arthur Williams.
4. Enterprise Risk Management: ICFAI Publishers