Dr. Babasaheb Ambedkar Technological University, Lonere.

Dr. Babasaheb Ambedkar Technological University
(Established as a University of Technology in the State of Maharashtra)
(under Maharashtra Act No. XXIX of 2014)
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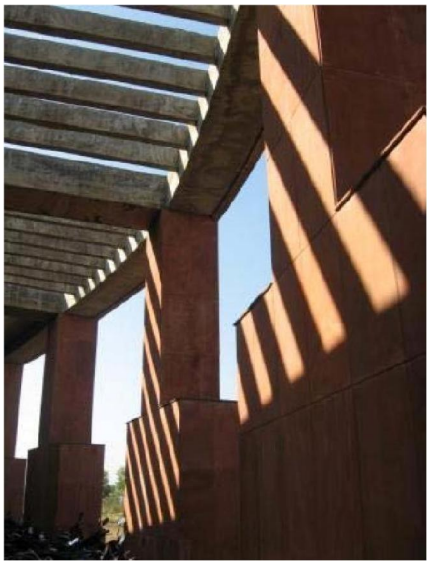
COURSE STRUCTURE AND SYLLABUS

For

B. Tech. Biomedical Engineering Programme

With effect from the Academic Year

2017-2018 (First Year), 2018-2019 (Second Year),
2019-2020 (Third Year), 2020-2021 (Final Year).



Dr. Babasaheb Ambedkar Technological University, Lonere.

Proposed Course Structure for

B. Tech Course in Biomedical Engineering

Semester III												
S. N.	Subject Code		Subject	Teaching Scheme			Evaluation Scheme			Total	Credits
				L	T	P	MSE	CA	ESE		
1	BTBM301		Mathematics for Biomedical Engineering	4	0	0	20	20	60	100	4
2	BTBM302		Basics of Human Anatomy and Physiology-I	3	0	0	20	20	60	100	3
3	BTBM303		Biomedical Transducers	3	1	0	20	20	60	100	4
4	BTBM304		Analog and Digital Circuits	3	0	0	20	20	60	100	3
5	ELE-I	BTBME305A	Communication Circuits and Systems	3	0	0	20	20	60	100	3
		BTBME305B	Biomedical Laser Instrumentation								
		BTBME305C	Nuclear Medicine								
6	BTBML306		Analog and Digital Circuits Lab	0	0	2	0	60	40	100	1
7	BTBML307		Biomedical Transducers Lab	0	0	2	0	60	40	100	1
8	BTBM308		Skill Set I	0	0	2	0	60	40	100	1
9	BTBMF309		Industrial Training-I(Evaluation of Training undergone after II Semester)	0	0	0	0	60	40	100	1
			TOTAL	**16**	**1**	**6**	**100**	**340**	**460**	**800**	**21**

Elective-I	
Subject Code	**Subject**
BTBME305A	Communication Circuits and Systems
BTBME305B	Biomedical Laser Instrumentation
BTBME305C	Nuclear Medicine

Semester IV											
S. N.	Subject Code		Subject	Teaching Scheme			Evaluation Scheme			Total	Credits
				L	T	P	MSE	CA	ESE		
1	BTBM401		Numerical Methods in Biomedical Engineering	4	0	0	20	20	60	100	4
2	BTBM402		Basics of Human Anatomy and Physiology-II	3	0	0	20	20	60	100	3
3	BTBM403		Fundamentals of Signals and Systems	3	1	0	20	20	60	100	4
4	BTBM404		Medical Instrumentation-I	3	0	0	20	20	60	100	3
5	BTBM405		Radiotherapy Equipment	3	0	0	20	20	60	100	3
6	BTBH406		Basic Human Rights	2	0	0	20	20	60	100	2
7	ELE-II	BTBME407A	Medical Radiation Safety Engineering	3	0	0	20	20	60	100	3
		BTBME407B	Quality Control and Regulatory Aspects in Medical Devices								
8	BTBML408		Medical Instrumentation-I Lab	0	0	2	0	60	40	100	1
9	BTBM409		Skill Set II	0	0	2	0	60	40	100	1
10	BTBMF410		Industrial Training-II (Evaluation of Training undergone after IV Semester)	-	-	-	-	-	-	-	-
			TOTAL	**21**	**1**	**4**	**140**	**260**	**500**	**900**	**24**

Elective-II	
BTBME407A	A. Medical Radiation Safety Engineering
BTBME407B	B. Quality Control and Regulatory Aspects in Medical Devices

Semester V												
S. N.	Subject Code		Subject	Teaching Scheme			Evaluation Scheme			Total	Credits
				L	T	P	MSE	CA	ESE		
1	BTBM501		Mathematics for Medical Imaging	4	0	0	20	20	60	100	4
2	BTBM502		Biomedical Signal Processing	3	1	0	20	20	60	100	4
3	BTBM503		Medical Instrumentation-II	3	0	0	20	20	60	100	3
4	BTBM504		Medical Imaging Systems	3	0	0	20	20	60	100	3
5	ELE-III	BTBME505A	Troubleshooting of Medical Instruments	3	0	0	20	20	60	100	3
		BTBME505B	Hospital Engineering								
		BTBME505C	Telemedicine and Picture Archival Communication System (PACS)								
		BTBME505D	NSS 2								
		BTBME505E	NSQF (Level 7 Course)								
6	ELE-IV Open	BME506A	Applied Optoelectronics in Medicine	3	0	0	20	20	60	100	3
		BME506B	Biomedical MEMS and Nanotechnology								
		BME506C	Applied Neural Networks and Fuzzy Logic in Medicine								
7	BTBML507		Biomedical Signal Processing Lab	0	0	2	0	30	20	50	1
8	BTBML508		Medical instrumentation-II Lab	0	0	2	0	30	20	50	1
9	BTBML509		Medical Imaging Systems Lab	0	0	2	0	30	20	50	1
10	BTBMF410		Industrial Training-II (Evaluation of Training undergone after IV Semester)	0	0	0	0	0	50	50	1
11	BTBMP511		Mini project	0	0	1	0	30	20	50	1
12	BTBMS512		Seminar	0	0	1	0	30	20	50	1
			TOTAL	**19**	**1**	**8**	**120**	**270**	**510**	**900**	**26**

BTBME505 (ELE-III)	**BTBME506 (ELE-IV) Open**
BTBME505A Troubleshooting of Medical Instruments	**BTBME506A** Applied Optoelectronics in Medicine
BTBME505B Hospital Engineering	**BTBME506B** Biomedical MEMS and Nanotechnology
BTBME505C Telemedicine and Picture Archival Communication System	**BTBME506C** Applied Neural Networks and Fuzzy Logic in Medicine
BTBME505D NSS 2	
BTBME505E NSQF (Level 7 Course)	

Semester VI												
S. N.	Subject Code		Subject	Teaching Scheme			Evaluation Scheme			Total	Credits
				L	T	P	MSE	CA	ESE		
1	BTBM601		Medical Image Processing and Analysis	3	1	0	20	20	60	100	4
2	BTBM602		Microprocessor and Microcontroller Based Biomedical Instrumentation	3	0	0	20	20	60	100	3
3	BTBM603		Biomaterials and Artificial Organs	3	0	0	20	20	60	100	3
4	BTBM604		Biomechanics, Prosthetics and Orthotics	3	0	0	20	20	60	100	3
5	ELE-V Open	BTBME605A	Artificial Intelligence and Pattern Recognition in Medicine	3	0	0	20	20	60	100	3
		BTBME605B	Brain-Computer Interface Development Engineering								
		BTBME605C	Electro Physiology For Human System								
6	ELE-VI Open	BTBME606A	Computational Fluid Dynamics analysis in Medicine	3	0	0	20	20	60	100	3
		BTBME606B	Physiological Modeling								
		BTBME606C	Robotics and Automation in Medicine								
7	BTBML607		Biomaterials, Prosthetics and Orthotics Lab	0	0	2	0	30	20	50	1
8	BTBML608		Medical Image Processing and Analysis Lab	0	0	2	0	30	20	50	1
9	BTBML609		Microprocessor and Microcontroller based Biomedical Instrumentation Lab	0	0	2	0	30	20	50	1
10	BTBML610		Mini project	0	0	1	0	30	20	50	1
11	BTBMS611		Seminar	0	0	1	0	30	20	50	1

12	BTBMF612	Industrial Training-III (Training to be undergone after VI Semester)	-	-	-	-	-	-	-	-
		TOTAL	**18**	**1**	**8**	**120**	**270**	**460**	**850**	**24**

BTBME605 (ELE-VI) Open	**BTBME606 (ELE-VI) Open**
BTBME605A-Artificial Intelligence and Pattern Recognition in Medicine	**BTBME606A-**Computational Fluid Dynamics analysis in Medicine
BTBME605B-Brain-Computer Interface Development Engineering	**BTBME606B-**Physiological Modeling
BTBME605C-Electro Physiology For Human System	**BTBME606C-** Robotics and Automation in Medicine

Semester VII											
S. N.	Subject Code		Subject	Teaching Scheme			Evaluation Scheme			Total	Credits
				L	T	P	MSE	CA	ESE		
1	BTBM701		Biomedical Control Systems	3	1	0	20	20	60	100	4
2	BTBM702		Virtual Instrumentation Design for Medical Systems	3	0	0	20	20	60	100	3
3	BTBM703		Rehabilitation Engineering	3	0	0	20	20	60	100	3
4	Elective-VII	BTBME704A	NSF Course III	3	0	0	20	20	60	100	3
		BTBME704B	Advanced Medical Imaging Systems								
		BTBME704C	Advanced Diagnostic and Surgical Equipment's								
		BTBME704D	Hospital Radio pharmacy								
5	Elective-VIII	BTBME705A	Home Medicare Technology	3	0	0	20	20	60	100	3
		BTBME705B	Design & Development of Medical Devices								
6	BTBML706		Biomedical Control Systems Lab	0	0	2	0	30	20	50	1
7	BTBML707		Virtual Instrumentation Design for Medical Systems Lab	0	0	2	0	30	20	50	1
8	BTBML708		Rehabilitation Engineering Lab	0	0	2	0	30	20	50	1
9	BTBMF612		Industrial Training-III (Training to be undergone after VI Semester)	0	0	1	0	0	50	50	1
10	BTBMP710		Project-I	0	0	1	0	30	20	50	4
			TOTAL	**15**	**1**	**8**	**100**	**220**	**430**	**750**	**24**

BTBME704 Elective-VII	**BTBME705 Elective-VIII**
BTBME704A-NSQF (Level 7 Course)	**BTBME705A -**Home Medicare Technology
BTBME704B- Advanced Medical Imaging Systems	**BTBME705B -**Design & Development of Medical Devices
BTBME704C-Advanced Diagnostic and Surgical Equipment's	
BTBME704D -Hospital Radio pharmacy	

Semester VIII										
S. N.	Subject Code	Subject	Teaching Scheme			Evaluation Scheme			Total	Credits
			L	T	P	MSE	CA	ESE		
1	BTBM801	Biomedical Microsystems	3	0	0	20	20	60	100	3
2	BTBM802	Advanced Diagnostic and Surgical Equipment's	3	0	0	20	20	60	100	3
3	BTBM803	Biomechanics	3	0	0	20	20	60	100	3
4	BTBML804	Biomedical Microsystems Lab	0	0	2	0	30	20	50	1
5	BTBML805	Advanced Diagnostic and Surgical Equipment's Lab	0	0	2	0	30	20	50	1
6	BTBMP808	Project Part-II	0	0	16	0	100	50	150	8
		TOTAL	**9**	**0**	**20**	**60**	**220**	**270**	**650**	**19**

SEMESTER III

BTBM301 MATHEMATICS FOR BIOMEDICAL ENGINEERING

Course Objectives:

- To impart analytical ability in solving mathematical problems as applied to Biomedical Engineering.

Course Outcome:

1. Learner will be able to formulate and solve partial differential equations.
2. Learner will be able to have thorough knowledge in Fourier series.
3. Learner will be able to be familiar with applications of partial differential equations.
4. Learner will be able to gain good knowledge in the application of Fourier transform.
5. Learner will be able to gain good knowledge in graph theory concepts.

UNIT I-PARTIAL DIFFERENTIAL EQUATIONS (12 hours)

Formation –Solution of standard types of first order equations –Lagrange's equation–Linear homogeneous partial differential equations of second and higher order with constant coefficients- Classification of second order linear partial differential equations including the reduction to the above types.

UNIT II-FOURIER SERIES (12 hours)

Dirichlet's conditions–General Fourier series–Half range Sine and Cosine series – Parseval's identity –Harmonic Analysis

UNIT III-ONEDIMENSIONAL WAVE & HEAT EQUATION (12 hours)

Boundary and initial value problems-Transverse vibrations of elastic string with fixed ends – Fourier series solutions–One dimensional heat equation- Steady and transient states– problems–Excluding thermally insulated ends.

UNIT IV-FOURIER TRANSFORMS (12 hours)

Statement of Fourier integral theorem (proof omitted) –Fourier transform pairs– Fourier Sine and Cosine transforms–Properties–Transforms of simple functions –Convolution theorem–Parseval's identity–Integral equations.

UNIT V-GRAPH THEORY (12 hours)

Graphs; Isomorphism-Walk; Path; Circuit; Shortest Path: Dijkstra's Algorithm; Tree; Properties of Tree; Binary Tree;Matrix Representation of Graphs (Adjacency and Incidence Matrices);

TEXT BOOKS/ REFERENCES

1. KreyszigE, Advanced "Engineering Mathematics", 10th edition, John Wiley & Sons, Singapore, 2012.
2. Veerajan T, Discrete "Mathematics"with Graph Theory and Combinatorics", 10th edition,Tata McGraw Hill Companies,2010.
3. Grewal B.S, Higher "Engg Maths", Khanna Publications, 42nd Edition, 2012.
4. Miller I.R.and Freund J.E., Probability and Statistics for Engineers, Prentice Hall, 5th edition, 1995.
5. Kandasamy P etal. "Engineering Mathematics", Vol. II & Vol. III (4th revised edition), S. Chand & Co., New Delhi, 2000.
6. Narayanan S., Manicavachagom Pillay T.K., Ramanaiah G., Advanced "Mathematics for Engineering students", Volume II & III (2nd edition), S.Viswanathan Printersand Publishers, 1992.
7. Venkataraman M.K., "Engineering Mathematics" - Vol.III- A & B (13th edition), National Publishing Co., Chennai, 1998.

BTBM302 BASICS OF HUMAN ANATOMY AND PHYSIOLOGY-I

Course Objectives:

- To understand clearly and identify the various parts of the human body, their anatomical position, their functions and how these can be used in the design of effective biomedical systems.

Course Outcomes:

1. Learner will be able to learn basics of human body, cell, and blood
2. Learner will be able to study about the positioning and functioning of the cardio vascular and respiratory systems
3. Learner will be able to study about the positioning and functioning of the nervous system and musculoskeletal system
4. Learner will be able to study about the positioning and functioning of the digestive and excretory system
5. Learner will be able to study about the positioning and functioning of the special organs and endocrine glands

UNIT I - INTRODUCTION HUMAN BODY-CELL, BLOOD (8 hours)

Overview of organ systems, Basic terminologies (Directional, regional, planes, feedback) - Cell: Different types of cells, Cell Structure and its organelles-Functions of each component in the cell - Membrane– transport across Membrane - Origin of cell membrane potential-Action potential and propagation-Blood-Composition-RBC, WBC and Platelets.

UNIT II-CARDIOVASCULAR AND RESPIRATORY SYSTEMS (9 hours)

Structure of heart - Circulation types- Cardiac cycle- Volume and pressure changes- ECG- Heart sounds- Blood pressure-Regulation of BP- Parts of respiratory system, Mechanics of respiration - Carbon dioxide and oxygen transport -Regulation of respiration -Volumes and capacities of lung, Types of hypoxia.

UNIT III-NERVOUS SYSTEM AND MUSCULOSKELETAL SYSTEM (9 hours)

Nerve cell anatomy - Functions of nervous system - Brain anatomy and hemispheres–Meninges-Cerebro Spinal Fluid-Circulation and Absorption-Spinal cord anatomy-Reflex action-PNS-Skeletal System-Functions-Anatomy of long bone–Formation, growth and repair- Structural and functional classification of joints - Functions of muscular system –Types of muscles - Sliding Filament Model-Neuromuscular junction-Physiology of muscle contraction

UNIT IV-DIGESTIVE AND EXCRETORY SYSTEM (9 hours)

Digestive system-Organization-Movements of GI tract - Digestion at various parts (Mouth to Large Intestine)-Accessory organs of Digestion (Salivary glands, Liver, Pancreas, Gall Bladder)–Defecation- Excretory System- Functions of urinary system -Microanatomy and functions of nephron -Physiology of urine formation–Micturition

UNIT V-SPECIAL ORGANS AND ENDOCRINE GLANDS (10 hours)

Eyes-retina Layers, Visual Pathway - Internal ear-Physiology-Auditory Pathway-Sense of Taste -Sense of Smell, touch-Endocrine glands-different glands and their hormones - Pituitary, Thyroid Parathyroid glands-Secretions- Maintenance of Calcium homeostasis-Maintenance of glucose homeostasis.

TEXTBOOKS/ REFERENCES

1. Arthur C, Guyton, John Hall.E “Textbook of Medical Physiology”, W.B.
2. Saunders Company, Twelfth edition, 2006
3. Sarada Subramanyam,Madhavan Kutty. K and Singh. H.D, “Text Book of
4. Human Physiology”–Chand. S,& Company, First Edition,1996.
5. RanganathanTS,“Text Book of Human Anatomy”, Chand S,&Co. Ltd.,
6. Fifth Edition,1996.

BTBM303 BIOMEDICAL TRANSDUCERS

Course Objective:

To gain knowledge about the measuring instruments and the methods of measurement.

Course Outcomes:

1. Learner will be able to get the basic idea of measurements and the errors associated with measurement
2. Learner will be able to know about the types of transducers available
3. Learner will be able to understand the function of signal generators and analyzers
4. Learner will be able to gain knowledge on functioning of the various measuring instruments and display devices in the application of biomedical signal recorders

UNIT I - MEASUREMENT SYSTEM AND BASICS OF TRANSDUCER (9 hours)

Measurements and generalized measurement system: Static characteristics, accuracy, precision, linearity, hysteresis, threshold, dynamic range- Dynamic Characteristics-calibration, standards and AC/DC bridges, Transducer: Basics, Classification, Characteristics and Choice, Primary sensing elements, POT, Thermistor, Thermocouple, Temperature compensation.

UNIT II - MEASUREMENT OF NON-ELECTRICAL QUANTITIES (9 hours)

LVDT, Strain gauges, Transducer: Pressure-, Capacitive-,Inductive-, Electrochemical-, Piezo-electric-, Hall effect-, Opto-electronic- Digital encoding/digital-, Fiber-optic-, Flow and liquid level-, and Electrochemical transducer.

UNIT III - SIGNAL GENERATORS AND SIGNAL ANALYZER (9 hours)

Signal generator: AF-,Pulse-, AM-, FM-, Function-, and Sweep frequency generator – Signal analyzer: Wave-, Spectrum-, Logic-, and Distortion- analyzer.

UNIT IV - DIGITAL DATA DISPLAY AND RECORDING SYSTEM (9 hours)

DVM and millimeters, Frequency, Period measurement, Time interval and pulse width measurement, Graphic recorders-strip chart, X-Y recorder, Magnetic tape recorder, CRO basics:

CRT, General purpose oscilloscope, Dual trace, Dual beam, Sampling oscilloscope, Digital storage oscilloscope.

UNIT V - MEDICAL APPLICATIONS OF SENSORS (9 hours)

Gas sensor, NBC agent, Microbial sensor, electro analytical sensor, Enzyme based sensor--Glucose sensor, Electronic nose- halitosis, breath analysis, Electronic nose-kidney disease, Skin analysis, Lung cancer, Advances in sensor technology: Lab-on-a –chip, Smart sensor, MEMS and Nano sensor, Enzyme immobilization of chemical analyses, Radiation sensor, Thermal radiation sensor.

TEXTBOOKS/ REFERENCES

1. Sawhney A.K, "A course in electrical and electronic measurements and instrumentation", Dhanpat Rai & Co (P) Ltd, Educational and Technical Publishers, 1996.
2. Cooper, "Electronic Instrumentation and Measurement techniques" Prentice Hall of India, 1998.
3. Renganathan S, "Transducer engineering", Allied Publishers Limited,2003.
4. Murty DVS, "Transducer and instrumentation", PHI, second edition, 2008.
5. Manoj Kumar Ram, Venkat R, Bhethanabolta, "Sensors for chemical and biological applications", CRC press, 2010
6. Patranabis D, "Sensors and transducers", PHI, Second Edition, 2004.
7. Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs and applications", Third edition, Springer International, 2010.
8. Doeblin, "Measurements Systems: Application and Design", Tata McGrawHill, 2003.
9. Neubert HKP, "Instrument Transducers", Oxford University Press, 1999.

BTBM304 ANALOG AND DIGITAL CIRCUITS

Course Objectives:

The purpose of this course is to impart knowledge in the field of Analog & Digital Electronics and its application in the field of Biomedical Engineering.

Course Outcomes:

1. To understand the basic analog & digital logic circuits.
2. To familiarize the concepts of counters and flip-flops
3. To gain knowledge about the memory organization and memory devices
4. To understand the concepts of different digital logic families for various applications
5. To study the applications of digital systems in the medical field

UNIT I

Physical structure and equivalent circuit models (large and small signal) of diode. Zener, photo-diode, Vari-cap, Schoktty diode, tunnel diode, power diode. Solar cell, direct band gap materials. Load line, graphical and iterative methods to obtain the current in a circuit that has a linear element like resistor and a non-linear device like diode. Rectifier circuits, Peak detector, voltage doubler, Shunt regulator using zener diodes. Physical structure and large and small signal models of BJT. Hybrid p model with Early effect, Logic Inverter, transistor as a switch, CE amplifier, biasing network, basic current mirror, current steering circuits, improved current mirrors such as Wilson current mirror, Widlar current source, etc.

UNIT II

BJT differential pair, CMRR, active loads, Darlington pair, cascade amplifier, BJT based input differential amplifier, intermediate stage and output stages of a typical operational amplifier. Physical structure and large and small signal models of MOSFETs, biasing, differential amplifier, current mirrors, improved current mirrors using MOSFETs, enhancement load device, body effect, active loads, CMOS Technology, NMOS inverter, NMOS inverter with active load, Design of CMOS inverters.

UNIT III

Frequency response of BJT and MOSFET based CE amplifiers and differential amplifiers, High frequency models and equivalent circuits. Op-amp fundamentals, basic circuits like integrator, practical integrator, buffer, inverting, non-inverting, differential and instrumentation amplifiers, negative impedance converter, generalized impedance converter.

UNIT IV

Static opamp limitations and compensating methods including on-chip, external and auto-zero schemes, chopper stabilized amplifiers. Switched-capacitor circuits, filters, precision rectifier circuits, current sources for floating and grounded loads, current amplifier, controlled positive feedback to increase input impedance, active compensation for input capacitance. Dynamic opamp limitations, slew rate, Full power band width, Noise, frequency response of opamps, Feedback stability issues and frequency compensation methods, log/antilog amplifiers, analog multipliers, Transconductance and transimpedance amplifiers.

UNIT V

ADCs and DACs, PLL and applications, Protection circuits for opamps, input and output over voltage and current protection, supply bypassing, avoiding faulty conditions, interference noise, shielding and guarding, dc leakage paths, Earth loops. Digital-overview, consensus theorem, timing analysis, static and dynamic hazards, multi-level NAND and NOR Gate circuits, CMOS NAND and NOR Gates.

UNIT VI

Latches, racing, master salve flip-flops, characteristic equations, sequential circuits. Synchronous state machine analysis, Moore and Mealy machines, state table, state diagram, design of synchronous state machines, ASM chart, design using programmable devices like PAL, PLA, FPGA etc.

TEXT BOOKS/ REFERENCES

1. Sedra and Smith, ‘Microelectronic circuits’.
2. Donald A Neamen, ‘Electronic circuit analysis and design’.

3. Ananth Agarwal, 'Foundations of analog and digital electronics'.

4. Jerald G Graeme, 'Operational amplifiers –Design and applications'.

5. Raon Pallas Arney, 'Analog signal processing'.

6. Sergio Franco, 'Design with operational amplifiers and analog integrated circuits'

BTBME305A ELECTIVE I

COMMUNICATION CIRCUITS AND SYSTEMS

Course Objectives:

To impart knowledge about transmission of analog and digital information using various modulation techniques and methods of enabling secured communication.

Course Outcomes:

1. Learner will be able to understand the different types of AM Communication systems
2. Learner will be able to study in detail about the different types of FM Communication systems
3. Learner will be able to familiarize about the base band data Communication systems
4. Learner will be able to gain knowledge about the different digital communication techniques
5. Learner will be able to know the spread spectrum modulation techniques and error control coding techniques

UNIT I - AMPLITUDE MODULATION (AM) (9 hours)

Modulation – Need of modulation, Mathematical representation of AM- DSB SC, AM- SSB SC, AM-VSB AM, Frequency spectrum, Bandwidth, power relation, Generation of AM – square law modulator and balanced modulator, Detection of AM: square law detector, envelope detector, AM transmitter, AM receiver –TRF and super heterodyne receiver.

UNIT II - FREQUENCY MODULATION (FM) (9 hours)

Mathematical representation of Frequency modulation, Frequency spectrum, Band Width, Generation of FM- Varactor diode modulator-Armstrong modulator, FM detection- Foster seely discriminator-Ratio detector, FM transmitter, FM receiver, Applications of FM, Advantages and Disadvantages

UNIT III - BASE BAND DATA COMMUNICATION (9 hours)

Sampling, Sampling Theorem, Quantization, PCM, ADPCM, DM, ADM, Base band pulse shaping: binary data formats, ISI, Nyquist criterion for distortion less baseband binary transmission, correlative coding

UNIT IV - DIGITAL MODULATION TECHNIQUES (9 hours)

Digital modulation Formats-ASK,FSK, PSK, Analog to Digital Conversion-PAM, PWM, PPM, Coherent binary-, and quadrature- modulations, and Non—coherent binary modulation: I and II types,M-array modulation.

UNIT V - SECUREDCOMMUNICATION AND MULTIPLE ACCESS TECHNIQUES (9 hours)

Introduction to spread spectrum, Pseudo-noise sequence, DS spread spectrum, processing gain, FH spread spectrum, multiple access techniques: FDMA, TDMA, CDMA.

TEXTBOOKS/ REFERENCES

1. Bernard Sklar and Pabitra Kumar Ray, “Digital Communications:
2. fundamentals and practice”, 2 nd edition, pearson edition, 2001.
3. Herbert Taub, Donald L, Schilling & Goutam Saha, “Principles of Communication Systems”, Third Edition, Tata McGraw Hill Publication, 2008.
4. Simon S, Haykins and Michael Mosher, “Digital Communication”, John
5. Wiley & sons, 2001.
6. John G, Proakis, Masoud Salehi, “Digital Communication”, fifth edition,
7. McGraw-Hill Higher Education, 2008.

BTBME305B ELECTIVE I

BIOMEDICAL LASER INSTRUMENTATION

Course Objectives:

To understand the fundamentals of different types of laser, its operations and applications in medical field.

Course Outcomes:

1. Learner will be able to study in-depth the principle of laser action and the characteristics of laser
2. Learner will be able to study about various types of laser and its mode of operation
3. Learner will be able to study various applications of lasers in medical field
4. Learner will be able to study and understand about holography and its applications
5. Learner will be able to design the experimental setup and can able to analyze the data.

UNIT I - OPTICAL PROPERTIES OF TISSUES (9 hours)

Scattering- Absorption- Refractive Index - Light transport inside the tissue Interaction of light with matter - quantum behavior of light - Light interaction with tissues – Opto-thermal interaction – Fluorescence - Speckles

UNIT II - BASIC THEORY OF LASER (9 hours)

LASER action : stimulated & spontaneous emission- Molecular energy level characteristics of laser- population inversion - Pumping methods and levels of pumping- Optical cavity configurations –Amplification - Optical resonator and gain - Q-switching - Mode locking- LASER modes - Line broadening

UNIT III - TYPES OF LASER (9 hours)

Solid state, Ruby, Nd:YAG, Tunable solid state, Alexandrite, Titanium-sapphire Gas lasers: Helium-Neon, Argon, Co2 - Tunable dye - Semiconductor

UNIT IV - HOLOGRAPHY AND ITS MEDICAL APPLICATIONS (9 hours)

Holography – Basic principle- methods of Holographic interferometry – applications - Holography for non-destructive testing –applications of LASER holography in medicine: Dentistry, Ophthalmology, Otology, Orthopedics.

UNIT V - MEDICAL APPLICATIONS OF LASER (9 hours)

Photo-chemical interaction- Thermal interaction- Photoablation - Plasma induced ablation – photo-disruption- Applications: Ophthalmology, Dentistry, Urology, Neurosurgery, Dermatology, Orthopedics, Angioplasty, Cardiology, and SurgeryDiffused optical tomography.

TEXTBOOKS/ REFERENCES

1. Thyagarajan K, Ajoy K, Ghatak A, “Lasers Fundamentals and Applications”, Second edition, Springer 2010.
2. Markolf H. Niemz, “Laser-Tissue Interactions: Fundamentals and Applications”, Third edition, Springer 2007.
3. Keiser, “Optical Fiber Communication Systems”, Mc Graw Hill Ltd., Third edition, 1983.
4. John E, Harry, “Industrial lasers and their applications”, Second edition, McGraw Hill, 1974.
5. John F Ready, “Industrial applications of lasers”, Second edition, Academic Press, 1978.

BTBME305C ELECTIVE I

NUCLEAR MEDICINE

Course Objective:

To understand the fundamentals of Nuclear Medicine and learn about the instruments involved in production techniques and therapeutic uses of Nuclear Medicine.

Course Outcome:

1. Learner will be able to learn the basics of nuclear medicine
2. Learner will be able to study the construction and principle of operation of various nuclear medicine instruments
3. Learner will be able to have some knowledge about the characteristics and mechanisms of radiopharmaceuticals
4. Learner will be able to study the diagnostics and therapeutic applications of nuclear medicine.
5. Learner will be able to have idea about the radiation safety procedures and regulations.

UNIT I - BASICS OF NUCLEAR MEDICINE (8 hours)

Radioactivity and interaction of radiation; Alpha, Beta and gamma emission, Laws of radioactive decay, Mechanisms of radioactive delay, Radiation intensity and exposure, Decay schemes and energy levels, Compton scattering, Pair productions, Particle interactions

UNIT II – RADIOPHARMACEUTICALS (9 hours)

Radionuclide production, ^{99}Mo/^{99}mTc generator, Mechanism of localization, Types of radio pharmaceuticals, characteristics of radio pharmaceuticals, Radiopharmaceuticals for diagnosis and treatments in human, Dispensing of radio pharmaceuticals, RIA radiopharmaceuticals and kits production.

UNIT III - NUCLEAR MEDICINE INSTRUMENTATION (9 hours)

Construction and principle operation of Gamma camera, Rectilinear scanner, Basic principles of pulse height analyser, Radiation detectors-Ionization chamber, Geiger Muller counter,

Semiconductor detectors, Scintillation detectors, Electronic Instrumentation for radiation detection system

UNIT IV - DIAGNOSTIC AND THERAPEUTIC APPLICATIONS OF RADIONUCLIDE

(10 hours)

PET-CT, Single photon emission computed tomography (SPECT), Radio iodine therapy for Thyrotoxicosis , Differentiated thyroid cancers, Palliative treatment for bone metastasis - 32 P and 89 Strontium Dosage, Intravascular particulate radio nuclide Therapy, Receptor targeted therapy, 131 I- MIBG Therapy, Targeted internal radiation in HCC: 90 Y, Radio-synovectomy using Yttrium

UNIT V - RADIATION SAFETY (9 hours)

Radiation protection indifferent nuclear isotope therapy procedures, Management of radiation accidents, Radiation effect on pregnancy and fertility, Diagnosis, evaluation and treatment of radiation overexposure, Instruments used in radiation survey & monitoring, Handling of radioactive patients, Role of national and international bodies in radiation safety, ICRP recommendations, BARC regulations regarding limits of radiation exposure

TEXTBOOKS/ REFERENCES

1. Simon Cherry, James Sorenson, Michael Phelps. “Physics in Nuclear Medicine”, Elsevier Saunders , 4 th Edition ,2012.
2. Jennifer Prekeges, “Nuclear Medicine Instrumentation”, Jones and Barlett publishers, 1st
3. edition, 2011.
4. Max.H.Lombardi, “Radiation safety in Nuclear Medicine”, CRC Press, Florida, USA, 2 nd edition 1999.

BTBM308 SKILL SET – I

UNIT I

Study of passive components (resistor, capacitor, inductor, transformer) their types, ratings and packages (through hole and SMD), types of PCB

UNIT II

Study of laboratory equipment (Electronics): Digital and Analog meters (Voltmeter, Ammeter, Ohmmeter, Multimeter), Cathode Ray Oscilloscope, Digital and Mixed-Signal Oscilloscope, Function generator, Component Tester, Types of solder metal (Sn-Pb with different ratios), Solder Iron, De-solder pump, Solder station (practice related assignments), Isolation transformer and its use

UNIT III

Study of electromechanical components (relays, actuators, dc motors , servo motors)

UNIT IV

Study of earthing techniques , testing for proper earthing

SEMESTER IV

BTBM401 NUMERICAL METHODS IN BIOMEDICAL ENGINEERING

Course Objectives:

To impart analytical ability in solving mathematical problems as applied to the respective branches of Engineering.

Course Outcomes:

1. Learner will be able to be familiar with numerical solution of equations
2. Learner will be able to get exposed to finite differences and interpolation
3. Learner will be able to be familiar with the numerical Differentiation and integration
4. Learner will be able to find numerical solutions of ordinary differential equations
5. Learner will be able to find numerical solutions of partial differential equations

UNIT I - CURVE FITTING AND NUMERICAL SOLUTION OF EQUATIONS (12 hours)

Method of Least Squares – Fitting a straight line – Fitting a parabola – Fitting an exponential curve – Fitting a curve of the form $y = ax^b$ – Calculation of the sum of the squares of the residuals-Eigen value problems by Power method – Jacobi method.

UNIT II - FINITE DIFFERENCES AND INTERPOLATION (12 hours)

First and Higher order differences – Forward differences and backward differences and Central Differences – Differences of a polynomial – Properties of operators – Factorial polynomials – Shifting operator E – Relations between the operators. Interpolation – Newton-Gregory Forward and Backward Interpolation formulae Divided differences – Newton's Divided difference formula – Lagrange's, Interpolation formula – Inverse interpolation.

UNIT III - NUMERICAL DIFFERENTIATION AND INTEGRATION (12 hours)

Numerical Differentiation and Integration: Newton's forward and backward differences formulae to compute first and higher order derivatives – The Trapezoidal rule – Simpson's one third rule and three eighth rule.

UNIT IV - NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS (12 hours)

Solution by Taylor's series – Euler's method – Improved and modified Euler method – Runge-Kutta methods of fourth order (No proof) – Milne's Method Adam's Bashforth method.

UNIT V - NUMERICAL SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS (12 hours)

Classification of Partial differential equations of the second order – Difference quotients – Laplace's equation and its solution by Liebmann's process – Solution of Poisson's equation – Solutions of Parabolic and Hyperbolic equations.

TEXT BOOK/ REFERENCES

1. Grewal, "Numerical Methods in engineering and science", Khanna Publishers, 42 nd edition, 2012.
2. Venkataraman M.K, "Numerical Methods in Science and Engineering", National Publishing Co., 2005.
3. Sastry S, "Introductory Methods of Numerical Analysis", 4 th edition,2005.
4. Balagurusamy, "Computer Oriented Statistical and Numerical Methods" – Tata McGraw Hill, 2000.
5. Jain K, SRK Iyengar and Jain R.L, "Numerical Methods for Scientific and Engineering Computation," Wiley Eastern Ltd., 4th edition,2003.

BTBM402 BASICS OF HUMAN ANATOMY AND PHYSIOLOGY-II

BTBM403 FUNDAMENTALS OF SIGNALS AND SYSTEMS

Course Objectives:

To familiarize with techniques suitable for analyzing and synthesizing both continuous-time and discrete time systems.

Course Outcomes:

1. To study and analyze the continuous and discrete-time signals and systems,their properties and representations.
2. To have Knowledge of time-domain representation and analysis concepts as they relate to difference equations, impulse response and convolution, etc.
3. To familiarize the concepts of frequency-domain representation and analysis using Fourier analysis tools, Z-transform.
4. To understand the concepts of the sampling process and to identify and solve engineering problems
5. To analyze the systems by examining their input and output signals

UNIT I - CLASSIFICATION OF SIGNALS AND SYSTEMS (10 hours)

Representation of discrete time signals, Elementary discrete time signal, Basic operation on signals, classification of signals-Deterministic and random signal, periodic and Non-periodic, Energy and power signal, causal and Non-causal signal, Even and Odd signal. Classification of systems- static and dynamic system, casual and non-causal system, linear and non-linear system, time variant and time invariant system, stable and unstable system

UNIT II - ANALYSIS OF CONTINUOUS TIME SIGNALS (10 hours)

Fourier series analysis-Trigonometric Fourier series, Cosine Fourier series, Exponential Fourier series, Fourier Spectrum of continuous time signals, Fourier transform analysis, Laplace transform, Analysis of electrical network using Laplace transform.

UNIT III - LTI CONTINUOUS TIME SYSTEMS (9 hours)

Analysis of differential equation-Transfer function-Impulse response-Frequency response-Convolution integral- Fourier Methods-Laplace transforms analysis, Block diagram representation-State variable equation and Matrix

UNIT IV - ANALYSIS OF DISCRETE TIME SIGNALS (7 hours)

Spectrum of DT signals-Discrete Time Fourier Transform (DTFT)-Properties of discrete time Fourier transform-Discrete Fourier Transform (DFT)-Properties of DFT-Z-transform in signal analysis-Properties of Z- transform-Inverse Z-transform

UNIT V - LTI DISCRETE TIME SYSTEMS (9 hours)

Analysis of differential equation-Transfer function-Impulse response-Frequency response-Convolution SUM –Fast Fourier transform- Block diagram representation-State variable equation and Matrix.

TEXTBOOKS/ REFERENCES

1. Anand Kumar A, “Signals and Systems” , PHI learning Pvt. Ltd., Second edition, 2012.
2. Simon Haykin and Barry Van Veen, “Signals and Systems” , John Willey & Sons, Inc., Second edition, 2004.
3. Ashok Ambardar, “Analog and Digital Signal Processing”, Thomson Learning Inc, Second Edition, 1999.
4. Allan V, Oppenhein et al, “Signals and Systems”, Prentice Hall of India Pvt. Ltd, Second edition, 1997.

BTBM404 MEDICAL INSTRUMENTATION-I

Course Objectives:

To gain basic knowledge about Bio potentials, Bio electrodes and bio amplifiers and to give a complete exposure of various recording mechanism and to understand the basic principles, working of biomedical instruments.

Course Outcomes:

1. To understand origin of bio-potential.
2. To study different types of electrodes used in bio-potential recording.
3. To understand the characteristics of bio-amplifiers and different types of recorders.
4. To understand how to measure various physiological parameters and helps to design simple biomedical sensors
5. To study the instrumentation concerned with measuring various parameters and the principle of working and gain knowledge on usage of instruments in hospitals and servicing.

UNIT I - BIOELECTRODES AND BIOCHEMICAL SENSORS (10 hours)

Components of Medical Instrumentation – System Origin of Bio potential: Action Potential, Nernst Equation, Goldman equation, Hodgkin- Huxley model – Electrode electrolyte interface, Half-cell potential, Polarisable and Non-polarisable electrodes - Skin electrode interface – Bio-electrodes: Surface-, Micro-. Needleelectrodes - Equivalent circuits of electrodes – Biochemical and Transcutaneous- electrodes: pH, pO2, pCO2 - Ion sensitive Field effect Transistors.

UNIT II - BIOAMPLIFIERS, BIOELECTRIC SIGNALS, PCG AND THEIR RECORDING (8 hours)

Bioamplifiers- Carrier Amplifier, - Isolation Amplifier - Differential amplifier Chopper Amplifier - Instrumentation Amplifier - Bioelectric signals (ECG, EMG, EEG, EOG & ERG) and their characteristics - Electrodes for ECG, EEG and EMG Einthoven triangle, Standard 12-lead configurations - ECG Machine – EMG machine – 10-20 electrodes placement system for EEG - EEG machine – Heart sound and characteristics, PCG

UNIT III - PATIENT MONITORING SYSTEMS AND BIOTELEMETRY (8 hours)

Measurement of Blood pressure – Direct Methods and Indirect Methods Temperature - Respiration rate - Heart rate measurement - Apnea detectors Oximetry -Pulse oximeter, Ear oximeter - Computerized patient monitoring system – Bedside, Central Monitoring system – Biotelemetry: Basics components, and its different types.

UNIT IV - CARDIAC MEASUREMENTS AND DEVICES (10 hours)

Cardiac output Measuring techniques – Dye Dilution method, Thermo dilution method, BP method - Blood Flow measuring Techniques: Electromagnetic Type Ultrasound Blood Flow meter, Laser Doppler Blood Flow meter – Cardiac Arrhythmias – Plethysmography - Cardiac Pacemakers – Defibrillator: AC-, and DC- types - Heart-Lung Machine (HLM) - Oxygenators

UNIT V - ANALYTICAL EQUIPMENTS (9 hours)

Chemical Fibro sensors, Fluorescence sensors - Glucose Sensor - Blood cell counters - Coulter counter, Electrical Impedance Method , Optical Method Colorimeter, Spectro photometer, Flame photometer – Chromatography – Mass Spectrometer - Electrical hazard – Micro- and Macro-shock - Patient safety Procedures.

TEXTBOOKS/ REFERENCES

1. Geoddes L.A, and Baker L.E, “Principles of Applied Biomedical Instrumentation”, John Wiley, 3 rd Edition, 1975, Reprint 1989.
2. Khandpur R.S, “Hand-book of Biomedical Instrumentation”, Tata McGraw Hill, 2nd Edition, 2003.
3. Leslie Cromwell, Fred Weibell J, Erich Pfeiffer. A, “Biomedical Instrumentation and Measurements”, Prentice-Hall India, 2nd Edition, 1997.
4. Stuart R, MacKay, “Bio-Medical Telemetry: Sensing and Transmitting Biological Information from Animals and Man”, Wiley-IEEE Press, 2nd Edition, 1968.
5. Leslie Cromwell, Fred J, Weibell, Erich A, Pfeiffer, “Biomedical Instrumentation and Measurements”, Prentice-Hall India, 2 nd Edition, 1997.

6. John G. Webster, "Medical Instrumentation application and design", John Wiley, 3rd Edition, 1997.
7. Carr, Joseph J, Brown, John.M "Introduction to Biomedical equipment technology", John Wiley and sons, New York, 4th Edition, 1997.
8. Rajarao C and Guha S.K."Principles of Medical Electronics and Bio-medical Instrumentation" ,Universities press (India) Ltd, First Edition, Orient Longman Ltd, 2001.

BTBM405 RADIOTHERAPY EQUIPMENTS

Course Objectives:

To provide the ability to work in different radiotherapy Equipments and its applications in Biomedical Engineering

Course Outcomes:

1. To make them understand the basics of radiotherapy physics
2. To impart the knowledge about the different pretreatment imaging and treatment verification
3. To gain in-depth knowledge about the radiotherapy effects
4. To make the students understand the function of various types of Radiotherapy equipments

UNIT I - RADIOTHERAPY PHYSICS & PRE-TREATMENT IMAGING (9 hours)

Atoms, nuclei and radioactivity- Radiation interactions with matter- Radiation measurement and detection- Imaging with X-ray, MRI and ultrasound-Imaging with radio nuclides- Therapy with unsealed radio nuclides-Radiotherapy beam production.

UNIT II - RADIATION TREATMENT PLANNING (9 hours)

Immobilization, localization and verification techniques- Principles and practice of radiation treatment planning- Brachytherapy-Networking, data and image handling and computing in radiotherapy- Quality management in radiotherapy.

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UNIT III – RADIOTHERAPYEFFECTS (9 hours)

Epidemiology of cancer-screening- Biological and pathological introduction Molecular, cellular and tissue effects of radiotherapy- Principles and management of patients with cancer-Chemotherapy and hormones- Skin and lip cancer-head and neck cancer.

UNIT IV - RADIOTHERAPY ASSISTING DEVICES (9 hours)

Features of conventional simulator and modern simulator – Immobilization equipment for head, neck, pelvic and extremities.

UNIT V - ADVANCED APPLICATIONS (9 hours)

Cobalt units, Gamma knife, Linear accelerators, Helical tomotheraphy, Ancillary equipment – Superficial and ortho voltage equipment

TEXTBOOKS/ REFERENCES

1. Symonds, Deehan, Meredith & Mills Walter and Miller, "Textbook of Radiotherapy: Radiation Physics, Therapy and Oncology", Churchill Livingstone, Seventh Edition, 2012.
2. Pam Cherry, Angela Duxbury, "Practical Radiotherapy-Physics and Equipment", John Wiley & Sons, Second Edition, 2009.
3. Todd Powliki, Peter Dunscombe B, Arno J, Mundt, Pierre Scalliet, "Quality and safety in radiotherapy", CRC Press, First Edition, 2010.
4. Subramania Jayaraman, Lawrence Lanzl H, "Clinical Radiotherapy Physics", CRC Press, Second Edition, 1996.

BTBM406 BASIC HUMAN RIGHTS

Course Objectives:

- To work for ensuring that basic human rights are respected everywhere.
- To cooperate to avoid compromising on human rights for economic or political expediency.
- To recognize democratic institutions as a fundamental human right.
- To work towards the sovereignty and self-determination of entities with historical, cultural and ecological identity.
- To actively engage with the Government of India and other countries to promote human rights education.
- To bring diplomatic and commercial pressures on regimes that violates human rights, to ensure that they respect the basic rights of their citizens.
- To keep the interests of disempowered communities foremost in all dealings with countries in which human rights violations occur.
- To develop a more distinctive and effective role for the International Court of Justice in the field of human rights.
- To promote a culture for educating the citizenry that cultivation and promotion of human rights culture is the sine qua non for the smooth functioning of the organs of a democratic State and for the kind of development that results into overall development of the society.
- To train the young men and women for facing the challenges of the pluralistic society and the rising conflicts and tensions in the name of particularistic loyalties to caste, religion, region and culture.
- To study the effects of draconian laws and unlawful use of State's machinery and force by the enforcement agencies.

Course Outcomes:

1. Simply put, human rights education is all learning that develops the knowledge, skills, and values of human rights.
2. The strengthening of respect for human rights and fundamental freedoms.
3. The enabling of all persons to participate effectively in a free society.

4. Learning about human rights principles, such as the universality, indivisibility, and interdependence of human rights.
5. Learning about regional, national, state, and local law that reinforces international human rights law.
6. Learning and knowing about and being able to use global, regional, national, and local human rights instruments and mechanisms for the protection of human rights.

UNIT I

THE BASIC CONCEPTS

Individual, group, civil society, state, equality, justice, Human Values: - Humanity, virtues, compassion.

UNIT II

HUMAN RIGHTS AND HUMAN DUTIES

Origin, civil and political rights, Contribution of American bill of rights, French revolution, Declaration of independence, Rights of citizen, Rights of working and exploited people, Fundamental rights and economic program, India's charter of freedom.

UNIT III

SOCIETY, RELIGION, CULTURE, AND THEIR INTER-RELATIONSHIP

Impact of social structure on human behaviour, Roll of socialization in human values, Science and Technology, modernization, globalization, and dehumanization.

UNIT IV

SOCIAL STRUCTURE AND SOCIAL PROBLEMS

Social and communal conflicts and social harmony, rural poverty, unemployment, bonded labour, Migrant workers and human rights violations, human rights of mentally and physically challenged.

UNIT V

STATE, INDIVIDUAL LIBERTY, FREEDOM AND DEMOCRACY

The changing of state with special reference to developing countries, Concept of development under development and social action, need for collective action in developing societies and methods of social action, NGOs and human rights in India: - Land, Water, Forest issues.

UNIT VI

HUMAN RIGHTS IN INDIAN CONSTITUTION AND LAW

The constitution of India: (i) Preamble

(ii) Fundamental rights.

(iii) Directive principles of state policy.

(iv) Fundamental duties.

(v) Some other provisions.

Universal declaration of human rights and provisions of India, Constitution and law, National human rights commission and state human rights commission.

TEXTBOOKS/ REFERENCES

1. Shastry, T. S. N., India and Human rights: Reflections, Concept Publishing Company India (P Ltd.), 2005.
2. Nirmal, C.J., Human Rights in India: Historical, Social and Political Perspectives (Law in India), Oxford India.

ELECTIVE II BTBMEA407

MEDICAL RADIATION SAFETY ENGINEERING

Course Objectives:

To impart sufficient information on the various precautionary and safety measures for radiation protection in medicine.

Course Outcomes:

1. To provide an insight to the basics of radiation physics.
2. To enable them understand the guidelines of radiation protection and radiation detectors.
3. To provide information on safety measures related to UV, laser and nuclear medicine

UNIT I - INTRODUCTION TO RF AND MICROWAVE RADIATION (9 hours)

Sources of radio frequency radiation- Effects of radio frequency radiation Development of standards for human safety- Calculation of RF field quantities- RF radiation measuring instruments and methods.

UNIT II - RADIATION DETECTION AND MEASUREMENT (9 hours)

Fundamentals of radiation detection- Conducting radiation measurements and surveys- Gas detectors- Designing to reduce radiation hazards- Radio frequency radiation safety management and training-Scintillation detectors- Statistics of counting- minimum detectable activity- Quality assurance of radiation counters.

UNIT III - RADIATION SAFETY IN NUCLEAR MEDICINE AND RADIOTHERAPY (9 hours)

Design and description of NM department- Radiation protection in nuclear industry- Guidelines for radiation protection- Molecular medicine and radiation safety program-procedures for safe operation of radiation equipment- Radiation protection in external beam radiotherapy- Radiation protection in brachytherapy Radioactive wastes.

UNIT IV - LASER AND ULTRAVIOLET RADIATION SAFETY (9 hours)

Classification of UV radiation -Sources of UV- Biological effects of UV- Hazards associated with UV radiation- UV control measures - Safety management of UV- Classifications of LASER and its radiation hazards- control measures Emergencies and incident procedures.

UNIT V - MONITORING AND INTERNAL DOSIMETRY (9 hours)

Monitoring methods-personal radiation monitoring- Records of personal dosimetry- ICRP method- MIRD method- Internal doses from radiopharmaceuticals- Bioassay of radioactivity- Hazard and risk in radiation protection- radiological incidents and emergencies- Regulation to radiation protection.

TEXTBOOKS/ REFERENCES

1. Jamie V, Trapp, Thomas Kron, "An introduction to radiation protection in medicine", crc press Taylor &Francis group, 2008.
2. Alan Martin, Samuel Harbison, Karen Beach, Peter Cole, Hodder Arnold, "An Introduction to radiation protection", 6th edition 2012.
3. Max Hlombardi, "Radiation safety in nuclear medicine", CRC Press Taylor & Francis group, 2nd edition, 2007.
4. Aruna Kaushik, Anupam mondal, Dwarakanath B.S, Tripathi R P, "Radiation protection manual", INMAS, DRDO, 2010.
5. Ronald kitchen, "RF and microwave radiation safety", Newness publishers, 2nd edition, 2001.

ELECTIVE II BTBMEB407
QUALITY CONTROL AND REGULATORY ASPECTS IN MEDICAL DEVICES

Course Objectives:

The course is designed to make the student better understanding of Quality standards and management methodologies in Biomedical Engineering.

Course Outcomes:

1. To understand the various quality standards & regulations used for healthcare
2. To get an overview of various methodologies used for management in healthcare

UNIT I - FUNDAMENTALS OF QUALITY MANAGEMENT (9 hours)

Definition of Quality, Dimensions of Quality, Quality Planning - Quality costs. Analysis Techniques of quality Cost - Basic concepts of Total Quality Management, Historical Review. - Principles of TQM, Leadership – Concepts, Role of Senior Management - Quality Council, Quality Statements – Strategic Planning - Deming Philosophy - Barriers to TQM Implementation

UNIT II - QUALITY MANAGEMENT PRINCIPLES (9 hours)

Customer satisfaction – Customer Perception of Quality - Customer Complaints, Service Quality, Customer Retention - Employee Involvement – Motivation, Empowerment - Teams and Team Work - 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 Measure

UNIT III - STATISTICAL PROCESS CONTROL (9 hours)

Seven Tools of Quality: I, II, and III - Concept of Six Sigma: I and II - New Seven Management tools: I and II - Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample - Normal Curve, Control Charts for variables and attributes, Process capability

UNIT IV - TQM TOOLS (9 hours)

Benchmarking – Reasons to Benchmark - Benchmarking Process – Quality Function Deployment (QFD) – House of Quality - QFD Process - Benefits Taguchi Quality, Loss Function - Total Productive Maintenance (TPM) – Concept, Improvement Needs - FMEA – Stages of FMEA

UNIT V - REGULATORY ORGANIZATIONS IN MEDICINE (9 hours)

Need for ISO 9000 and Other Quality Systems - ISO 9000:2000 Quality System – Elements, Implementation of Quality System - Quality Auditing - Need for Accreditation of hospitals - FDA Regulations- Joint Commission – Regulatory Bodies of India-Medical Council of India - Pharmacy Council Of India, Indian Nursing Council - Dental Council of India, Homeopathy Central Council

TEXTBOOKS/ REFERENCES

1. Rose J.E, “Total Quality Management”, Kogan Page Ltd., 1993.
2. Cesar A. Cacere & Albert Zana, ”The Practise of clinical Engineering”, Academic Press, Newyork, 1997.
3. John Bank, "The Essence of Total Quality Management", Prentice Hall of India, 1993.
4. Webster J G, and Albert Cook M, “Clinical Engineering, Principles & Practices”, Prentice Hall Inc., Engle wood cliffs, New Jersey, 1979.

BTBM409 SKILL SET- II

UNIT I

Study of any one EDA (Electronic Design Automation) tool (Multisim/Altium Designer or any equivalent open source software)

UNIT II

Study of Schematic capture of a simple circuit, Simulation of the same circuit, Single –sided or double sided PTH layout design, Bill of materials.

UNIT III

Study of any documentation tool (Microsoft Office Word and Microsoft Office Visio or equivalent open source software)

UNIT IV

Assignment includes preparing a complete technical report of an existing medical electronic product with specifications, block diagram and features, Presentation to be prepared based on the report generated in existing medical electronic product with specifications.

UNIT V

Survey report preparation, Assignment includes comparative survey of commercially available medical electronic product and preparation of a report.

SEMESTER V

BTBM501 MATHEMATICS FOR MEDICAL IMAGING

Course Objectives:

- To gain knowledge in linear models of biological systems.
- To learn about non linear equations in biomedical engineering.
- To gain knowledge on probability concepts.
- To learn the methods of studying correlation and regression.
- To learn about ANOVA.

Course outcomes:

1. To develop an understanding of the methods of probability which are used to model engineering problems.
2. To develop an understanding of the methods of statistics which are used to model engineering problems.

UNIT I- LINEAR MODELS OF BIOLOGICAL SYSTEMS (12 hours)

Introduction, Examples of linear biological systems, Simultaneous liner algebraic equations, solutions by Gauss Elimination and Gauss Jordan, Iterative approach for solution of linear systems, Gauss-Jacobi and Gauss seidal method.

UNIT II - NONLINEAR EQUATIONS IN BIOMEDICAL ENGINEERING (12 hours)

Introduction, General form of non-liner equations, Examples, Bi section method, Method of direct iteration, Method of false position, Newton Raphson method.

UNIT III - PROBABILITY AND THEORETICAL DISTRIBUTIONS (12 hours)

Probability concepts, conditional probability, Baye"s theorem, one dimensional random variables, expectation, variance, moments. Theoretical distributions : Binomial, Poisson, Normal (Problems only).

UNIT IV - CORRELATION AND REGRESSION ANALYSIS (12 hours)

Methods of studying correlation, Karl pearson"s coefficient of correlation, Rank correlation method, Regression analysis, Regression lines, Regression equations, Regression coefficients

UNIT V - ANALYSIS OF VARIANCE (12 hours)

Small sample tests based on t and F distribution, Test for single mean, difference between means, Paired t-test, test for equality of variances. ANOVA-one -way classification, Two-way classification.

TEXT BOOKS

1. Stanley Dunn, Alkies Constantinides & Prabhas V. Moghe, "Numerical methods in Bio medical engineering", Academic press, 2006.
2. Gupta S.C, & Kapoor V.K, "Fundamentals of Mathematical Statistic"s, Sultan Chand and Sons, 11th edition, New Delhi, 2007.

REFERENCES

1. Gupta S.C & Kapoor V.K, "Fundamentals of Applied Statistics", Sultan Chand and Sons, New Delhi, 2003.
2. Ewans W & Grant G, "Statistical Methods in Bio informatics - An Introduction", Springer, 2nd edition, 2005.

BTBM502 BIOMEDICAL SIGNAL PROCESSING

Course Objectives:

1. To make them understand the fundamentals of signal processing for various bio-signal analysis
2. To impart knowledge about filter characteristics and to design various filters
3. To provide an in-depth knowledge about the basic concepts of wavelet and speech analysis
4. To apply various signal processing techniques in analyzing the various bio-signal
5. To study about the characteristics of non stationary signals

Course outcomes:

1. To learn the fundamental concepts of signal processing
2. To apply common signal processing techniques for various biomedical signals.

UNIT I - FUNDAMENTALS OF SIGNAL PROCESSING (8 hours)

Sampling and aliasing, Signal reconstruction, Signal conversion systems, Circular convolution Correlation, Autocorrelation, Cross correlation, FFT, decimation in time algorithm, Decimation in Frequency algorithm.

UNIT II - DIGITAL FILTER DESIGN (10 hours)

Basics of filter, Design of IIR filter-impulse invariant method, Bilinear Transformation Method Warping and pre-warping effect, Frequency transformation, Characteristics of FIR filter, FIR filter design using windowing techniques, Rectangular window, Hamming window, Hamming window

UNIT III - WAVELET AND SPEECH PROCESSING (9 hours)

Introduction to wavelets, Time frequency representation, Discrete wavelet transform, pyramid algorithm, Comparison of Fourier transform and wavelet

transform, Speech analysis, Cepstrum, Homomorphic filtering of speech signals, EEG signal characteristics, EEG analysis.

UNIT IV - ANALYSIS OF BIOSIGNALS (9 hours)

Automatic analysis and classification of ECG, P-wave detection, QRS complex detection, Correlation analysis of ECG signals, Signal averaged ECG, Analysis of Heart Rate variability, Synchronized averaging of PCG envelopes, envelogram, Analysis of PCG signal, Analysis of EMG signal.

UNIT V - ADVANCED TOPICS IN BSP (9 hours)

Analysis of non-stationary signals, time variant system, Fixed segmentation, Short time Fourier transform, autocorrelation function method, Spectral error measure method, generalized likelihood ratio, Introduction to Adaptive filters, Adaptive segmentation.

TEXTBOOKS

1. John G, Proakis and Dimitris Manolakis G. "Digital Signal Processing, Algorithms and Applications", PHI of India Ltd., New Delhi, fourth Edition, 2007.
2. Rangaraj M Rangayyan, "Biomedical signal processing", IEEE press, first edition, 2002.

REFERENCES

1. Reddy D.C, "Biomedical Signal Processing: Principles and Techniques", Tata McGraw-Hill, New Delhi,2nd edition ,2005.
2. Sanjit. K, Mitra "Digital Signal Processing", A Computer Based Approach", Tata McGraw-Hill, New Delhi, fourth edition 2011.

BTBM503 MEDICAL INSTRUMENTATION-II

Course Objectives:

1. To learn about pulmonary analyzers and aid equipment's and their functions on respiratory system.
2. To provide clear knowledge about physiotherapy and electrotherapy equipment's.
3. To gain knowledge about instruments dealing with kidney and bones.
4. To provide clear knowledge about the instruments used for sensory measurements and able to design sensors.
5. To provide latest knowledge of special medical assistive and therapeutic equipment's and learn how to use that equipment's and servicing.

Course outcomes:

1. To acquire an adequate knowledge about measurement of various physiological parameters.
2. To understand the fundamental principle and working of the biomedical instruments involved in the measurement.

UNIT I - PULMONARY ANALYZERS AND AID EQUIPMENTS (9 hours)

Regulation of Breathing, Pulmonary gas flow measurements, Pulmonary volume measurements, Respiratory gas analyzers, Nitrogen Gas Analyzer, Oxygen Analyzer, Humidifier, Nebulizer, Ventilators, IPPB Unit, Anesthesia machine

UNIT II - PHYSIOTHERAPY AND ELECTROTHERAPY EQUIPMENTS (10 hours)

Tissue response, Short ware diathermy, Microwave diathermy, Ultrasonic therapy Unit, Eletrotherapy, FES, TENS, Bladder stimulator, Lithotripter system, Extra corporeal Shock wave therapy.

UNIT III - INSTRUMENTS DEALING WITH KIDNEY AND BONES

Regulation of Water and Electrolyte Balance, Artificial Kidney, Hemo dialysis, Crafts for dialysis, Peritoneal dialysis, Dialyzers, different types, BMD Measurements, SXA, DXA, Quantitative ultrasound bone densitometer

UNIT IV - SENSORY INSTRUMENTATION (10 hours)

Mechanism of Hearing, Sound Conduction System, Basic Audiometer, Pure toneaudiometer, Audiometer system Bekesy, Hearing Aids, Ophthalmoscope, Tonometer, Measurement of Basal Skin response and Galvanic skin response, Instruments for testing Motor responses, Experimental Analysis of Behavior, Biofeedback Instrumentation

UNIT V - SPECIAL EQUIPMENTS (7 hours)

Endoscopy, Laparoscopy, Cryogenic Equipment, Automated drug delivery system, Components of drug infusion system, Implantable infusion systems.

TEXTBOOKS

1. Geoddes L.A, and Baker L.E, "Principles of Applied Biomedical Instrumentation", John Wiley, 3rd Edition, 1975, Reprint 1989.
2. Khandpur R.S, "Hand-book of Biomedical Instrumentation", Tata McGraw Hill, 2nd Edition, 2003.
3. Leslie Cromwell, Fred J, Weibell, Erich Pfeiffer A, "Biomedical Instrumentation and Measurement", Prentice-Hall India, 2nd Edition,1997.

REFERENCES

1. Stuart MacKay R, "Bio-Medical Telemetry: Sensing and Transmitting Biological Information from Animals and Man", Wiley-IEEE Press, 2nd Edition, 1968.

2. John G, Webster, "Medical Instrumentation application and design", JohnWiley, 3rd Edition, 1997.
3. Carr Joseph J, Brown, John M, "Introduction to Biomedical equipment technology", John Wiley and sons, New York, 4th Edition, 1997.
4. Rajarao C, and Guha S.K, "Principles of Medical Electronics and Biomedical Instrumentation", Universities press (India) Ltd, First Edition, Orient Longman ltd, 2001.

BTBM504 MEDICAL IMAGING SYSTEMS

Course Objectives:

- To gain knowledge in medical imaging systems.

Course outcomes:

1. To acquire an adequate knowledge about measurement of various physiological parameters.
2. To understand the fundamental principle and working of the biomedical instruments involved in the measurement.

UNIT I - PULMONARY ANALYZERS AND AID EQUIPMENTS (9 hours)

Regulation of Breathing, Pulmonary gas flow measurements, Pulmonary volume measurements, Respiratory gas analyzers, Nitrogen Gas Analyzer, Oxygen Analyzer, Humidifier, Nebulizer, Ventilators, IPPB Unit, Anesthesia machine.

UNIT II - PHYSIOTHERAPY AND ELECTROTHERAPY EQUIPMENTS (10 hours)

Tissue response, Short ware diathermy, Microwave diathermy, Ultrasonic therapy Unit, Electrotherapy FES, TENS, Bladder stimulator, Lithotripter system, Extra corporeal Shock wave therapy.

UNIT III - INSTRUMENTS DEALING WITH KIDNEY AND BONES (9 hours)

Regulation of Water and Electrolyte Balance, Artificial Kidney, Hemo dialysis, Crafts for dialysis, Peritoneal dialysis, Dialyzers, different types, BMD Measurements, SXA, DXA, Quantitative ultrasound bone densitometer.

UNIT IV - SENSORY INSTRUMENTATION (10 hours)

Mechanism of Hearing, Sound Conduction System, Basic Audiometer, Pure toneaudiometer, Audiometer system Bekesy, Hearing Aids, Ophthalmoscope, Tonometer, Measurement of Basal Skin response and Galvanic skin response,

Instruments for testing Motor responses, Experimental Analysis of Behavior, Biofeedback Instrumentation

UNIT V - SPECIAL EQUIPMENTS (7 hours)

Endoscopy, Laparoscopy, Cryogenic Equipment, Automated drug delivery system, Components of drug infusion system, Implantable infusion systems.

TEXTBOOKS

1. Geoddes L.A, and Baker L.E, "Principles of Applied Biomedical Instrumentation", John Wiley, 3rd Edition, 1975, Reprint 1989.
2. Khandpur R.S, "Hand-book of Biomedical Instrumentation", Tata McGraw Hill, 2nd Edition, 2003.
3. Leslie Cromwell, Fred J, Weibell, Erich Pfeiffer A, "Biomedical Instrumentation and Measurement", Prentice-Hall India, 2nd Edition,1997.

REFERENCES

1. Stuart MacKay R, "Bio-Medical Telemetry: Sensing and Transmitting Biological Information from Animals and Man", Wiley-IEEE Press, 2nd Edition, 1968.
2. Stuart MacKay R, "Bio-Medical Telemetry: Sensing and Transmitting Biological Information from Animals and Man", Wiley-IEEE Press, 2nd Edition, 1968.
3. John G, Webster, "Medical Instrumentation application and design", Carr Joseph J, Brown, John M, "Introduction to Biomedical equipment technology", John Wiley and sons, New York, 4th Edition, 1997.
4. Rajarao C, and Guha S.K, "Principles of Medical Electronics and Biomedical Instrumentation", Universities press (India) Ltd, First Edition, Orient Longman ltd, 2001.

BTBM505A ELECTIVE-III

TROUBLESHOOTING OF MEDICAL INSTRUMENTS

Course Objectives:

- To provide adequate technical information on operating principles of medical instruments to attain mastery in fault detection and corrective measures.

Course outcomes:

1. To provide knowledge to students to enable them to troubleshoot the various equipments used in hospitals.

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.

UNIT II - TESTING OF PASSIVE COMPONENTS & SEMICONDUCTOR DEVICES (8 hours)

Testing: resistors, capacitors & inductors, causes of failure for electronic components, testing procedure for semiconductor devices: special diodes, bipolar transistors, field effect transistor (FET), and thyristor.

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

Fault Diagnosis in Op-Amp Circuits, Digital Troubleshooting Methods, Digital IC Troubleshooters, Circuit board Troubleshooting.

UNIT IV - BIOMEDICAL EQUIPMENT TROUBLESHOOTING -I (10 hours)

Trouble shooting of ECG Machine, EEG Machine, Defibrillator Electrosurgical unit, Anaesthesia machine, Autoclaves & sterilizers, Endoscope.

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

Troubleshooting of Incubators, Nebulizer, Oxygen Concentrators, Oxygen

TEXTBOOKS

1. Khandpur R S, "Troubleshooting Electronic Equipment- Includes Repair & Maintenance", Tata McGraw-Hill, Second Edition 2009.
2. Dan Tomal & Neal Widmer, "Electronic Troubleshooting", McGraw Hill, 3rd Edition 2004.

REFERENCES

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

BTBM505B ELECTIVE-III

HOSPITAL ENGINEERING

Course Objectives:

1. To obtain the knowledge about the basic planning and organization of hospitals
2. To study about the clinical and administrative services
3. To impart knowledge on designing of hospital services
4. To study and analyze the infection control and safety management in hospitals

Course outcomes:

1. To provide the knowledge of planning .designing and safety management in hospital services

UNIT I - PLANNING AND ORGANIZATION OF THE HOSPITALS (9 hours)

Roles of hospital in healthcare-hospital planning and design-outpatient services-the nursing unit-intensive care unit-nursing services-effective hospital management-directing and leading-controlling - financial management.

UNIT II - CLINICAL AND ADMINISTRATIVE SERVICES (9 hours)

Radiology and imaging services-laboratory services-operation theatre suite-pharmacy-central sterile supply department- hospital infection- materials management-evaluation of hospital services.

UNIT III - DESIGNING OF HOSPITAL SERVICES (9 hours)

Engineering department - maintenance management- clinical engineering-electrical system- air conditioning system- water supply and sanitary system-centralized medical gas system-communication system- solid waste management and transportation.

UNIT IV - DESIGNING SUPPORT SERVICES AND SAFETY MANAGEMENT

(9 hours)

Admitting department- medical records department- food service department- laundry and linen service-housekeeping- volunteer department- safety in hospital- fire safety- Alarm system- disaster management.

UNIT V - HOSPITAL INFECTION CONTROL (9 hours)

Importance of infection control-hand hygiene-aseptic techniques-isolation precautions-disinfection and sterilization-clinical laboratory standards to infection control-health care workers safety.

TEXTBOOKS

1. Kunders G D, "Biomechanics: Hospitals, facilities planning and management", Tata Mcgraw Hill, 2008.
2. Sakharkar B M, "Principles of hospital administration and planning", Jaypee Brothers Medical Publishers Pvt Limited, 2nd edition, 2009.

REFERENCES

1. Sanjiv Singh, Sakthikumar Gupta, Sunil Kant, "Hospital infection control guidelines, principles and practice", Jaypee Brothers Medical Publishers Pvt Limited, First edition, 2012.

BTBME505C ELECTIVE-III

TELEMEDICINE AND PICTURE ARCHIVAL COMMUNICATION SYSTEM (PACS)

Course Objectives:

- To study about fluoroscopic imaging techniques and components.
- To learn about the principle, reconstruction ,artifacts with CT imaging
- To understand the basics and advancement in fMRI
- To learn about microwave and infrared medical imaging modalities.
- To understand the concepts of radioisotope and nuclear imaging

Course outcomes:

1. To introduce the students to advanced medical imaging techniques enabling the students to work professionally in the biomedical engineering sector and other medical imaging related industry in designing systems, components, products or processes to meet desired needs of these industries in health care wing.

UNIT I - FLUOROSCOPY (9 hours)

Fluoroscopic imaging chain components, Characteristics of Image intensifier performance, Modes of operation, Image quality, Radiation dose, Fluoroscopic suites, Peripheral equipment, Optical coupling, Video cameras.

UNIT II-COMPUTED TOMOGRAPHY (9 hours)

Basic Principles, Geometry and Historical Development, Detectors and Detector Arrays, Details of Acquisition, Tomographic Reconstruction, Digital Image Display, Radiation Dose, Image Quality, Artifacts, Optical Tomography.

UNIT III-FMRI (9 hours)

Introduction to FMRI, Basics of MRI Signal, Tissue contrast and spatial localization, Neuronal activity and Hemodynamics, BOLD FMRI, SNR in FMRI, Experimental design , FMRI statistics land 2, Advanced FMRI.

UNIT IV - MICROWAVE AND INFRARED IMAGING (9 hours)

Introduction, Electromagnetic scattering, Elecromagnetic inverse scattering problem, Imaging configuration, Model approximations, Qualitative reconstruction methods, Microwave imaging apparatus, Infrared imaging, Thermography, Clinical applications of thermography, liquid crystal thermography.

UNIT V - RADIO ISOTOPE IMAGING AND NUCLEAR MEDICINE (9 hours)

Radio nuclides for imaging: Cyclotron, Nuclear reactor, and Generator production, Rectilinear, and linear scanners SPECT, PET, Gamma Camera, Comparison of tomographic techniques, Radiation dosimeter, Radiation protection.

TEXTBOOKS

1. Khandpur R S, *"Hand-book of Biomedical Instrumentation",* Tata McGraw Hill, 2nd Edition, 2003.
2. William hendee R, Russell Ritenour E, *"Medical imaging physics",* Fourth Edition, 2002.

REFERENCES

1. Stephan Ulmer, Olav Jansen, "FMRI: Basics and Clinical Applications", springer, first Edition,2010.
2. Matteo Pastorin , "Microwave imaging", John Wiley and Sons ,first edition , 2010.

BTBME505D ELECTIVE-III

NSS 2

Course Objectives:

- To imbibe in the minds of students the concepts and benefits of NCC/NSS/NSO/YOGA and make them practice the same.

Course Outcomes:

1. To enable the students to gain knowledge about NCC/NSS/NSO/YOGA and put the same into practice

NATIONAL CADET CORPS (NCC)

Any student enrolling as a member of National Cadet Core (NCC) will have to attend sixteen parades out of twenty parades each of four periods over a span of academic year Attending eight parades in first semester will qualify a student to earn the credits specified in the curriculum' Grading shall be done based on punctuality, regularity in attending the parades and the extent of active involvement

NATIONAL SERVICE SCHEME (NSS)

A student enrolling as member of NSS will have to complete 60 hours of training / social service to be eligible to earn the credits specified in the curriculum' Grading shall be done by the faculty member handling the course based on punctuality, regularity in attending the classes and the extent of active involvement'

NATIONAL SPORTS ORGANIZATION (NSO)

Each student must select one of the following games/sports events and practice for one hour per week. An attendance of 75% is compulsory to earn the credits specified in the curriculum. Grading shall be done by the faculty member handling the course based on punctuality, regularity in attending the classes and the extent of active involvement. List of games/sports: Basket Ball, Football, Volley Ball, Ball Badminton, Cricket, Throw-ball, Track events Field events or any other game with the approval of faculty member.

YOGA

Benefits of Agnai Meditation -Meditation - Agnai, Asanas, Kiriyas, Bandas, Muthras Benefits of santhi Meditation - Meditation Santhi Physical Exercises (I & II) Lecture & Practice - Kayakalpa Yoga Asanas, Kiriyas, Bandas, Muthras Analysis of Thought - Meditation Santhi Physical Exercises III & IV Benefits of Thuriyam - Meditation Thuriyam Kayakalpa Asanas, Kiriyas, Bandas, Muthras Attitude - Meditation Thuriyam Kayakalpa Asanas, Kiriyas, Bandas, Muthras Importance of Arutkappy & Blessings - Meditation Thuriyam Kayakalpa Asanas, Kiriyas, Bandas, Muthras Benefits of Blessings - Meditation Santhi Kayakalpa Asanas, Kiriyas, Bandas, Muthras

REFERENCES/TEXTBOOKS

1. Yogiraj Vethathiri Maharishi, "Yoga for Modern Age", Vethathiri Publishers, 1989.
2. Vethathiri Maharishi T, "Simplified Physical Exercises", Vethathiri Publishers,1987.

BTBM506A ELECTIVE-IV

APPLIED OPTOELECTRONICS IN MEDICINE

Course Objectives:

- To know the basics of solid state physics and understand the nature and characteristics of light
- To understand different light modulation techniques and the concepts and ' applications of optical switching
- To study the integration process and application of opto electronic ' integrated circuits in transmitters and receivers

Course outcomes:

1. To get familiar with the different types of optical emission, detection, modulation and opto-electronic integrated circuits and their applications

UNIT I - LIGHT SOURCES AND DISPLAY DEVICES(12 hours)

Photo Luminescence, Cathode Luminescence, Electro Luminescence, Injection Luminescence, LED, Laser Emission, Absorption, Population Inversion, Threshold condition, Optical Feedback, Laser Modes, Classes of Lasers, Pulsed Lasers, Plasma Display, Liquid Crystal Displays, Numeric Displays'

UNIT II - OPTO-ELECTRONIC DETECTION METHODS (9 hours)

Basic principles of opto-electronic detection, Types of Photodiodes, Thermal detector, Photo Devices, Photo conductors, Photo detectors, Detector performance, Noise considerations

UNIT III - OPTOELECTRONIC MODULATOR (9 hours)

Basic principles, Analog and digital modulation, Electro-optic modulators, Magneto optic devices, Acousto-optic devices, Optical switching, Logic devices-optical switching,

UNIT IV - OPTICAL AMPLIFIER & OPTOELECTRONIC INTEGRATED CIRCUITS

(9 hours)

Semiconductor optical amplifier, Erbium doped fiber amplifier, Fiber Raman Receivers, Guided wave devices, Principles of optical biosensors, Application of opto-electronic integrated circuits

UNIT V - APPLICATIONS OF OPTOELECTRONIC DEVICES (6 hours)

Cardiovascular and intensive care sensors, FBG for strain and temperature measurement

TEXTBOOKS

1. Wilson J and Hawkes J.F.B, *"Opto Electronics - An Introduction",* second edition, Prentice Hall of India Pvt. Ltd., New Delhi, 1998.
2. Safa O Kasap, *Optoelectronics and Photonics: Principles and practices,* firstt edition,PHI, 2009

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REFERENCES

1. John G, Webster, "Medical Instrumentation application and design", JohnWiley, 3rd Edition, 1997.
2. Carr Joseph J, Brown, John M, "Introduction to Biomedical equipment technology", John Wiley and sons, New York, 4th Edition, 1997.

BTBME506B ELECTIVE-IV

BIOMEDICAL MEMS AND NANO TECHNOLOGY

Course Objectives:

- To enable the students to acquire knowledge about the principles & application of BioMEMS & Biomedical Nanotechnology

Course outcomes:

1. Learner will be able to understand the working principle of MEMS & Microsystems.
2. Learner will be able to understand the MEOMS Technology.
3. Learner will be able to understand the concepts of BioMEMS & its application in healthcare.
4. Learner will be able to give insight to the DNA based BioMEMS.
5. Learner will be able to study about the biomedical Nanotechnology & its application in research domain.
6. To develop an understanding of the methods of statistics which are used to model engineering problems.

UNIT I MEMS & MICROSYSTEMS

EMS and Microsystems- Introduction - Typical MEMS and Microsystem Products - Application of Micro-system in Healthcare Industry – Working Principles of Microsystems Micro-sensors - Micro-actuation - MEMS with Micro- actuation - Micro-accelerators & Micro-fluidics - aterials for MEMS & Microsystems.

UNIT II MICRO-OPTO ELECTROMECHANICAL SYSTEMS & MICROFLUIDICS

Fundamental principle of MOEMS Technology - Light Modulators, Beam splitter -Micro-lens, Micro-mirrors - Digital Micro-mirror Device, Light detectors - Important Consideration on Micro-scale fluid, Properties of fluid - Fluid Actuation

UNIT III BIOMEMS

BIOMEMS-Introduction, the driving force behind the biomedical Application - Principle of Biosensor, Ampero-metric Biosensor - Multi-analyte measurement, Micro-dialysis - BioMEMS

for Clinical Monitoring - Multi-parameter monitoring - Monitoring of Glucose & Lactate with a micro-dialysis probe – Ammonia Monitoring - Electronic Nose, DNA Sensors,

UNIT IV

DNA BASED BIOMEMS

Introduction, Unique features of Nucleic Acids,Lab on the Chip, Electrophoresis, Polymerase Chain Reaction (PCR), Biochemical reaction chains for integration: Biosensors & the "lab biochip", Typical Microarray experiment, Manufacturing of Microarrays, Synthesis on the chip, Spotting Techniques, PCR on the chip, Micro- chamber Chips, Micro-fluidics Chips, Emerging BioMEMS Technology.

UNIT V - BIOMEDICAL NANOTECHNOLOGY

Introduction to nanoscale phenomena, Nanoparticles- Nanomaterial characterization -XRD, SAXS, TEM, SEM, Scanning Tunneling microscopy, AFM, SPM technique, Biomolecular sensing for cancer diagnostics using carbon nanotubes, Carbon nanotube biosensors, Magnetic nanoparticles for MR Imaging, Nano-devices in biomedical applications.

TEXTBOOKS

1. Steven S, Saliterman, "Fundamentals of BioMEMS & Medical Microdevices", International Society for Optical Engineering, First Edition 2006.

2. Nitaigour Premchand Mahalik, "MEMS", Tata McGraw Hill, 2nd Reprint 2008.

3. Wanjun Wang & Steven A.Soper , "BioMEMS- Technologies and applications", CRC Press, First edition 2007.

REFERENCES

1. Tai-Ran Hsu, "MEMS & Microsystems- Design, Manufacture and Nanoscale Engineering", John Wiley & Sons, 2nd Edition 2008.
2. Gerald A Urban, "BioMEMS", Springer, First Edition 2006.
3. Abraham P. Lee and James L. Lee, "BioMEMS and Biomedical Nanotechnology", Volume I, Springer, First Edition 2006.

4. Paul C.H. Li, "Introduction to Microfluids and BioMEMS: A Design and Problem-Solving Textbook", CRC Press, First Edition 2009.
5. Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology", Academic Press, First Edition 2002.
6. Guozhong Cao & Ying Wang, "Nanostructures and Nanomaterials- Synthesis, Properties and Applications", World Scientific, 2nd Edition 2011.

BTBME506C ELECTIVE-IV

APPLIED NEURAL NETWORKS AND FUZZY LOGIC IN MEDICINE

Course Objectives:

- To understand the basic concepts of Artificial intelligence structures and strategies
- To understand the concepts of knowledge representation in AI
- To study the different pattern recognition techniques and feature extraction based on clustering
- To give an insight knowledge about the different types of classification techniques
- To study about the application of AI in medical field

Course Outcomes:

1. To enable the students to acquire knowledge about the artificial intelligence techniques
2. To recognize the patterns and its application in medicine.

UNIT I - ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI): Introduction, definition & history, Components, Problem definition- Structures and Strategies for state space search- Depth first and breadth first search- DFS with iterative deepening- Heuristic Search- Best First Search- A* Algorithm- AND, OR Graphs, Problems

UNIT II - KNOWLEDGE REPRESENTATION IN AI

Propositional- and Predicate- calculus, Theorem proving by resolution, AI representational schemes- Semantic nets, Conceptual graphs: Using frames and scripts- Production system, Rule based expert system

UNIT III - PATTERN RECOGNITION

Classes, patterns & features- Pattern similarity and PR Tasks- Pattern discrimination-Feature space metrics & Covariance matrix- Feature assessment-

Unsupervised clustering- Tree clustering- K-means clustering, Statistical, syntactic and descriptive approaches.

UNIT IV - CLASSIFICATION

Linear discriminants, Bayesian classification, Bayes rule for minimum risk, minimum error rate classification, discriminant functions, and decision surfaces, Model free technique - ROC Curve, Classifier evaluation, Back propagation learning, Competitive learning.

UNIT V - APPLICATIONS IN MEDICINE

Diagnosis of disease using AI, Biometrics: Face recognition and Gene matching- Automated drug delivery systems- Computer aided diagnosis- Mining of electronic health record- Computer vision

TEXTBOOKS

1. George F Luger, "Artificial Intelligence- Structures and Strategies for Complex Problem Solving", 4/e, 2002, Pearson Education.
2. Duda and Hart P E, "Pattern classification and scene analysis", John wiley
3. and sons, NY, 1973.

REFERENCES

1. Earl Gose, Richard Johnsonbaugh, and Steve Jost; "PatternRecognition and Image Analysis", PHI Pvte. Ltd., NewDelhi-1, 1999.
2. Fu K S, "Syntactic Pattern recognition and applications", Prentice Hall, Eaglewood cliffs, N J, 1982.
3. Rochard O, Duda and Hart P E, and David G Stork, "Pattern classification", 2nd Edn., John Wiley & Sons Inc., 2001.
4. Carlo Combi, Yuval Shahar; "Artificial Intelligence in Medicine" - 12th Conference - Springer.

SEMESTER VI

BTBM601 MEDICAL IMAGE PROCESSING AND ANALYSIS

Course Objectives:

- To learn the image fundamentals and mathematical transforms necessary for image processing
- To study the various image enhancement techniques
- To apply various image restoration procedures in Medical images.
- To gain knowledge about the basic concepts of image compression procedures.
- To study about the various segmentation techniques applied to Medical Images.

Course Outcomes:

1. Learner will be able to learn the fundamental concepts of medical image acquisition
2. Learner will be able to understand how to apply the image processing techniques for various medical images.

UNIT I - FUNDAMENTALS OF DIGITAL IMAGE AND TRANSFORMS

Elements of Visual perception, Image sampling and quantization, Neighborhood pixel Relationships - Basic Image operations - Arithmetic, Geometric and Morphological, Image transform: 2D DFT- Discrete cosine-, Sine-, Haar-, and Hadamard- transform.

UNIT II - IMAGE ENHANCEMENT

Basic gray level transformation, Histogram processing ,Smoothening by spatial filters - Sharpening by spatial filters ,Smoothening- frequency domain filters, Sharpening- frequency domain filters ,Color image Processing- color models- Pseudo color image processing- Color Image Transformation - Smoothening - Sharpening.

UNIT III - IMAGE SEGMENTATION AND OBJECT RECOGNITION

Edge detection- Marr Hidreth edge detector - Canny edge detector, Thresholding-foundation - Basic global thresholding - Basic Adaptive thresholding, Region Based segmentation, Watershed segmentation algorithm, Patterns and pattern classes, Recognition based on decision theoretic methods-matching, Optimum statistical classifiers.

UNIT IV - IMAGE COMPRESSION

Image compression- Fundamentals - Image compression standards- Coding: Run length-, Huffman- Arithmetic-, Bit plane-, Transform- and Lossy- and lossless-predictive coding.

UNIT V - IMAGE RESTORATION AND RECONSTRUCTION OF MEDICAL IMAGES

Image degradation models, Algebraic approach to restoration, inverse filtering, Least mean square filter, Image reconstruction from projections - Radon transforms - Filter back projection algorithm - Fourier reconstruction of MRI Images.

TEXTBOOKS

1. Geoddes L.A, and Baker L.E, "Principles of Applied Biomedical Instrumentation", John Wiley, 3rd Edition, 1975, Reprint 1989.
2. Rafael C, Gonzalez and Richard E Woods, "Digital Image Processing", Pearson Education Asia, Third Edition, 2007.
3. Anil K Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India, 2nd edition 1997.

REFERENCES

1. William K Pratt, "Digital Image Processing", John Wiley NJ, 4th Edition, 2007.
2. Albert Macouski, "Medical Imaging systems", Prentice Hall, New Jersey 2nd edition 1997.

BTBM602 MICROPROCESSOR AND MICROCONTROLLER BASED BIOMEDICAL NSTRUMENTATION

Course Objectives:

- To understand the functioning of different microprocessors and microcontrollers and to use microprocessor for various applications in biomedical instrumentation

Course outcomes:

1. Learner will be able to study the concept of basic microprocessor 8085
2. Learner will be able to study the concept of microprocessor 8086
3. Learner will be able to get knowledge about various interfacing devices
4. Learner will be able to interface device with the processors
5. Learner will be able to study the concept of microcontroller.

UNIT I - MICROPROCESSOR-8085

Evolution & Importance of microprocessor, Microprocessor-8085: Introduction, feature, architecture, pin diagram, addressing mode, instruction set, timing diagram, interrupt- Programming exercise

UNIT II - MICROPROCESSOR-8086

Microprocessor-8086: Introduction, comparison with microprocessor-8085, feature, architecture, pin diagram, addressing mode, instruction set, minimum- and maximum- mode, assembler directives and operators, interrupts- Programming exercise

UNIT III - PERIPHERAL DEVICES

Interfacing: Memory- and I/O- interfacing- Programmable Peripheral Interface (PPI)-8255: Pin diagram, block diagram, and operating modes- Programmable Communication Interface (PCI)-8251 USART: Pin diagram, block diagram, and command word- Programmable Interrupt Controller (PIC)-8259A: Pin diagram, block diagram, interrupt sequence, and cascading- Keyboard/Display Controller- 8279: Pin diagram, block diagram, operating modes- DMA Controller-8237: Pin diagram, and block diagram

UNIT IV - MICROCONTROLLER-8051

Introduction to 8 bit microcontroller, bus configuration, reset circuitry – power down considerations, architecture of 8031/8051, Signal descriptions of 8051, Register set of 8051, Memory- and I/O Interfacing: Interrupts, instruction set, and addressing mode- Simple Programs

UNIT V - APPLICATIONS IN MEDICINE

Mobile phone based bio signal recording, microprocessor based vision architecture for integrated diagnostic helping devices, and Microprocessor based remote health monitoring system: Concept and systems, and system operation.

TEXTBOOKS

1. Ramesh S Gaonkar, "Microprocessor architecture, programming and its application with 8085", Penram Int. Pub. (India), Fifth edition, 2002.

2. Roy A, Bhurchandi K K.M, "Intel Microprocessors Architecture, Programming and Interfacing", McGraw Hill International Second Edition 2006.

REFERENCES

1. Muhammad Ali Mazidi and Janica Gilli Mazidi, "The 8051 microcontroller and embedded systems", Pearson Education, Fifth edition, 2003.

2. Rafiquzzaman M, "Microprocessors - Theory and Applications" Intel and Motorola, Prentice Hall of India Pvt. Ltd, Second edition, 2001.

3. Douglas V Hall, "Microprocessors and Interfacing programming and hardware", Tata McGraw Hill, Fourth Edition, 2003.

BTBM603 BIOMATERIALS AND ARTIFICIAL ORGANS

Course Objectives:

1. To gain knowledge in linear models of biological systems.
2. To know about the different classes of materials used in medicine
3. To gain knowledge about the application of biomaterials in medicine
4. To understand the concept of biocompatibility and the methods of biomaterial testing

Course outcomes:

1. Learner will be able to understand the principles and biology underlying the design of implants and artificial organs.

UNIT I - BIOMATERIAL PROPERTIES

Biomaterial -definition, Material characterization - Mechanical, thermal, Phase diagrams, Surface properties, Structure and properties of naturally occurring materials - Collagen, Bone, Teeth, Skin, Causes of failure - micro cracks, crazing, fatigue. Technologies of biomaterials processing - Surface coatings methods

UNIT II - CLASSES OF BIOMATERIALS

Different classes of materials used in medicine - Polymers - Synthesis - Mechanical & Thermal properties - Polyesters - Polyacrylates - Polyanhyrides - Biodegradable Polymers - Hydrogels - Elastomer - Dendrimers. Metals - Stainless steel - Cobalt-Chromium alloy - Titanium alloys. Ceramics and Bioglasses - nonabsorbable bioceramics - biodegradable ceramics -bioreactive ceramics - deterioration of ceramics - Other Bioactive materials, Composites as biomaterials

UNIT III - SOFT AND HARD TISSUE APPLICATIONS

Sutures, Wound dressings, artificial skin - Drug delivery devices - Cardiovascular medical devices - Heart valves, Assist devices-Stent and grafts, Orthopedic

fixation devices - Internal - External - Joints, Total Hip Arthroplasty - Evolution-Design.

UNIT IV - MATERIAL RESPONSE

Material and Tissue interaction, biological environment and host response - Inflammation, Wound Healing and Foreign Body Response - Failure mechanisms; corrosion, fracture, degradation of Implanted Materials - Polymers,Metals,ceramics.

UNIT V - BIOMATERIAL TESTING AND ARTIFICIAL ORGANS

Testing of biomaterials: In-vitro, in-vivo preclinical tests - biocompatibility - methods for improvement, surface modification of materials - implant retrieval and evaluation. Artificial Heart, eye and ear implants, artificial pancreas, ophthalmic implantation, dental implantation, insulin administration devices, extracorporeal artificial organs, neural prostheses.

TEXTBOOKS

1. Joon Bu Park, Roderic S, Lakes, "Biomaterials", Springer-Verlag, New York Inc., 2010.
2. Ratner A, and S.Hoffman, B. D. "Biomaterials Science: An Introduction to Materials in Medicine", Academic Press; 3 edition,November 8, 2012.

REFERENCES

1. Chua, Chena.J.Y, Wanga.L.P, N.Huang, *"Plasma-surface modification of biomaterials",* Materials Science and Engineering: R: Reports, Volume 36, Number 5, 29 March 2002, pp. 143-206 (64).

BTBM604 Biomechanics Prosthesis and Orthosis

Course Objectives

- To recall the general characteristics, mechanical properties of bone and tissues.
- To analyze the forces at joints for various static and dynamic human activities; analyze the stresses and strains in biological tissues.
- To understand principles used in designing orthoses and prostheses.
- To study different materials used for orthoses and prosthesis.
- To understand the fabrication of prostheses and orthoses.

Course Outcomes

A learner will be able to:

1. Understand the definition of biomechanics, prostheses orthoses and its classification and design principles.
2. Develop a better understanding of how mechanical principles influence human motion during everyday life.

UNIT-I

Force system: Classification of force system. Equilibrium of force system.

UNIT-II

Tissue Biomechanics: Direct shear, bending and torque actions and the corresponding stresses and strains in biological tissues. Stress relaxation and creep. Bone structure & composition, Mechanical properties of bone, Fracture mechanism & crack propagation in bones. Soft connective (skin, tendon, ligaments, etc.) covering structure function, and physiological factors.

UNIT-III

Movement Biomechanics: Study of joints and movements. Anatomical levers, Gait Analysis.

UNIT-IV

Joint analysis: Instrumentation for gait analysis: Measurement devices- footswitches, instrumented

UNIT-V

Principles in designing orthoses and prostheses: Principles of three point pressure, total contact, partial weight bearing.

UNIT-VI

Classification in prosthetics and orthotics:Lower Extremity orthoses and prostheses, Upper Extremity orthoses and prostheses. Spinal orthoses.

TEXTBOOKS

1. Basic Biomechanics-Susan J. Hall, MC Graw Hill.
2. Basics of Biomechanics" by Dr. Ajay Bahl and others
3. Basic Biomechanics of the Musculoskeletal System,M. Nordin,V.Frankel
4. Human Limbs and their substitutes –Atlas, C. V. Mosby
5. American Atlas of Orthopedics: Prosthetics, C. V. Mosby.
6. American Atlas of Orthopedics: Orthotics, C. V. Mosby
7. Biomechanics -Prof Ghista (Private Publication UAE)
8. Biomechanics –By White and Puyator (Private Publication UAE)

REFERENCES

1. Introductory Biomechanics: from cells to tissues by Ethier and Simmons
2. Biomechanics: Mechanical properties of living tissues by Y. C. Fung

BTBME605A ELECTIVE-V

ARTIFICIAL INTELLIGENCE AND PATTERN RECOGNITION IN MEDICINE

Course Objectives:

- To gain knowledge in linear models of biological systems.
- To learn about nonlinear equations in biomedical engineering.
- To gain knowledge on probability concepts.
- To learn the methods of studying correlation and regression.
- To learn about ANOVA.

Course Outcomes:

1. To develop an understanding of the methods of probability which are used to model engineering problems.
2. To develop an understanding of the methods of statistics which are used to model engineering problems.

UNIT I - ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI): Introduction, definition & history, Components, Problem definition- Structures and Strategies for state space search- Depth first and breadth first search- DFS with iterative deepening- Heuristic Search- Best First Search- A* Algorithm- AND, OR Graphs, Problems.

UNIT II - KNOWLEDGE REPRESENTATION IN AI

Propositional- and Predicate- calculus, Theorem proving by resolution, AI representational schemes- Semantic nets, Conceptual graphs: Using frames and scripts- Production system, Rule based expert system

UNIT III - PATTERN RECOGNITION

Classes, patterns & features- Pattern similarity and PR Tasks- Pattern discrimination- Feature space metrics & Covariance matrix- Feature assessment- Unsupervised clustering- Tree clustering- K-means clustering, Statistical, syntactic and descriptive approaches

UNIT IV - CLASSIFICATION

Linear discriminants, Bayesian classification, Bayes rule for minimum risk, minimum error rate classification, discriminant functions, and decision surfaces, Model free technique - ROC Curve, Classifier evaluation, Back propagation learning, Competitive learning

UNIT V - APPLICATIONS IN MEDICINE

Diagnosis of disease using AI, Biometrics: Face recognition and Gene matching- Automated drug delivery systems- Computer aided diagnosis- Mining of electronic health record- Computer vision

TEXTBOOKS

1. George F Luger, "Artificial Intelligence- Structures and Strategies for Complex Problem Solving", 4/e, 2002, Pearson Education.
2. Duda and Hart P E, "Pattern classification and scene analysis", John wiley and sons, NY, 1973.

REFERENCES

1. Earl Gose, Richard Johnsonbaugh, and Steve Jost; "PatternRecognition and Image Analysis", PHI Pvte. Ltd., NewDelhi-1, 1999.
2. Fu K S, "Syntactic Pattern recognition and applications", Prentice Hall, Eaglewood cliffs, N J, 1982.
3. Rochard O, Duda and Hart P E, and David G Stork, "Pattern classification", 2nd Edn., John Wiley & Sons Inc., 2001.
4. Carlo Combi, Yuval Shahar; "Artificial Intelligence in Medicine" - 12th Conference - Springer.

BTBME605B ELECTIVE-V

BRAIN-COMPUTER INTERFACE DEVELOPMENT ENGINEERING

Course Objectives:

- To gain knowledge in linear models of biological systems.
- To study the hardware and software components of BCI
- To familiarize the concepts of the classifiers for BCI
- To understand the feature extraction methods for classifying BCI
- To gain knowledge in BCI based on visually evoked potentials
- To study the analysis of visuo-motor tasks in a BCI

Course Outcomes:

1. Learner will be able to understand the biophysical basis of non-invasive brain signals, to apply signal processing, discrimination, and classification tools to interpret these signals, and to implement these tools into a control system for a brain-computer interface.

UNIT I - HARDWARE/SOFTWARE COMPONENTS OF BCI

Introduction, Components and signals, Electrodes, Bio signal amplifier, Real-time processing environment, Motor imagery, P300 spelling device, SSVEP, Accuracies achieved with different BCI principles, Applications-twitter, second life, smart home control with BCI

UNIT II - APPLIED ADVANCED CLASSIFIERS FOR BCI

Introduction, Signal processing and feature selection, Flow of the online and offline activities, Windowing, FFT, Statistical analysis procedure, Reduction of the feature space dimensionality, Neural network Classifier for BCI devices , Experimental procedures-ANN, SVM.

UNIT III - FEATURE EXTRACTION METHODS IN CLASSIFYING EEG SIGNAL FOR BCI

Introduction-Methods, Mutual information, Min max mutual information, Experimental setup, Data set, Results, P300-based BCI Paradigm Design- Event-Related Potentials (ERPs), P300 detection, Applications of P300.

UNIT IV - BCI BASED ON THE FLASH ONSET AND OFFSET VEP

Introduction- Methods- Peak-to-valley amplitudes in the onset and offset FVEPs, Determination of gazed target, Usability of Transient VEPs in BCIs- VEPs, Availability of transient VEPs, Machine learning approach

UNIT V - VISUO-MOTOR TASKS IN A BCI ANALYSIS

Introduction-Visuo motor tasks, Subjects and EEG sessions-Signal processing and fuzzy estimator, Advances in Non-Invasive BCI for Control and Biometry-Beam forming BCI, EEG based biometry

TEXTBOOKS

1. Reza Fazel-Rezai, *"Recent Advances in Brain-Computer Interface Systems",* Intech Publications, First Edition, 2011.
2. Theodre Berger W, John k Chapin et all, *"Brain computer interfaces, An International assessment of research and developmental trends",* Springer, First Edition, 2008.

REFERENCES

1. Guido Dornhege, "Toward brain-computer interfacing", MIT Press, First Edition, 2007.

BTBM605C ELECTIVE-V

ELECTRO PHYSIOLOGY FOR HUMAN SYSTEM

Course Objectives:

- To understand the basics of the cell physiology
- study about the electro cardiology
- perform the electrical activity of the muscles physiology
- understand the function and nerve conduction study about the peripheral nervous system

Course outcomes:

1. Learner will be to understand the concepts and methods of electrical bio physics in the diagnosis and treatment of human diseases.

UNIT I - INTRODUCTION TO CELL PHYSIOLOGY

Level of organizing the body-chemical level, cellular level, organ level, organism level-Concept of membrane potential-Membrane potential is separation opposes changes. Electrical field in cells and Organism-Electrical structure of the living organism-extracellular field and currents-passive -action potential-electrical tissue and cell suspension-single cell in external electrical field-manipulation of cell by electric field.

UNIT II - ELECTRICAL CARDIAC PHYSIOLOGY

Electrical activity of the heart-cardio auto rhythmic display pace maker activity, the action potential of contractile cell-ECG record is record of the overall spread electrical activity through the heart, different part of the ECG record can be correlated specific events, ECG diagnosis the abnormal events-Mechanical events of the cardiac cycle-Cardiac output its control.

UNIT III - ELECTRICAL MUSCLE PHYSIOLOGY

Molecular basis of the skeletal muscle contraction-Skeletal muscle fibred, myosin forms thick filaments-Muscle mechanics- Group of muscle fiber, types of

contraction, EMG motor unit: EMG conduction motor unit, Muscle motor unit recruitment, Muscles fiber frequency of stimulation- Types of muscles based on the ATP hydrolysis and synthesis.

UNIT IV - NERVE CONDUCTION

Nerve impulse-neurotransmitter and synapse- Passive transport and den tries-active transport and Hodgkin-Huxley equation-EEG- neurotransmitter-nerve conduction of EEG signal-Simulation of action potential-excitation threshold, neuronal refractoriness, repetitive spiking-Fitzhugh-Nagumo model-action potential in earthworm nerve fiber.

UNIT V - PERIPHERAL NERVOUS SYSTEM: SPECIAL SENSE

Pain-simulation of nociceptors elicits the perception of the pain plus motivational and emotional response. Eye: protective mechanism help of prevent eye injuries-light controlled by iris-EOG oculography measure the resting potential of retina. ENG (Electronystagmography), oculomotor evaluation-position testing-caloric simulation of the vestibular system.

TEXTBOOKS

1 Laura lee Sherwood, "Human Physiology from cell to system", eighth edition, 2012.
2 Laura lee Sherwood, "Fundamental of Physiology of Excitable Cells", 2010.

REFERENCES

1 Lionel Opie, "Heart Physiology" 2009.
2 Aidley, "7he Physiology of Excitable Cells", 3rd/4 the edition, 2008. Cambridge PressJames Cal Comb, Jonathan Tran "Introductory Biophysics", 2009.
3 Roland Glaser, "Biophysics an introduction", Second edition, 2009.

BTBME606A ELECTIVE-VI
COMPUTATIONAL FLUID DYNAMICS ANALYSIS IN MEDICINE

Course Objectives:

- To understand the fundamentals of fluid dynamics
- To understand the importance of CFD and numerical methods
- To get an insight into FEM, FDM & FVM
- To study the fundamentals of discretization
- To know about the application of CFD in biomedical domain

Course outcomes:

1. Leaner will be able tvo enable the students to acquire knowledge about Computational Fluid Dynamics which is useful in analysis & design of various fluid flow medical devices

UNIT I - BASIC CONCEPTS & FUNDAMENTALS OF FLUID DYNAMICS

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 - INTRODUCTION TO CFD & OVERVIEW OF NUMERICAL METHODS

Computational fluid dynamics (CFD): What, When & Why, CFD 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 - INTRODUCTION TO FEM, FDM & FVM

Finite element method (FEM) - Finite difference method (FDM)- Finite volume method (FVM) - Its application in medicine.

UNIT IV - FUNDAMENTALS OF DISCRETIZATION

Discretization principles: Pre-processing, Solution, Post-processing, Finite Element Method, Finite difference method, Well posed boundary value problem, Possible types of boundary conditions, Conservativeness, Boundedness, Transportiveness, Finite volume method (FVM), Illustrative examples: 1-D steady state heat conduction without and with constant source term, Comparison of Discretization techniques.

UNIT V - CFD IN MEDICINE

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.

TEXTBOOKS

1 Robert W, Fox, Philip J, Pritchard, Alan McDonald T "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.

REFERENCES

1 Chung T J, "Computational Fluid Dynamics", Cambridge University Press, 2nd Edition 2010.
2 John D, Anderson, Jr, "Computational Fluid Dynamics The Basics with Applications", Tata Mcgraw Hill, First Edition 2012.
3 Blazek J, "Computational Fluid Dynamics: Principles & Applications", Elsevier, 1st Edition 2001.
4 Ferziger J H & Peric M, "Computational Methods for Fluid Dynamics", Springer, 3rd Edition 2002.

5 Versteeg H K, & Malalasekara W, "Introduction to Computational Fluid Dynamics: The Finite Volume Method", Pearson Education, 2nd Edition 2008.

6 Shaw C T, "Using Computational Fluid Dynamics", Prentice Hall, First Edition 1992.

BTBME606B ELECTIVE-VI
PHYSIOLOGICAL MODELING

Course Objectives:

- To understand the process of modeling to various physiological systems.
- To study the mathematical tools for analyzing the model.
- To perform time domain and frequency domain analysis of the physiological models
- To impart knowledge on simulation techniques for analyzing the systems.
- To provide an in-depth knowledge on modeling of physiological system

Course Outcomes:

1. To understand and gain knowledge about methods of finding solutions to biological problems using computational tools.

UNIT I - INTRODUCTION TO PHYSIOLOGICAL CONTROL SYSTEMS

Introduction to Physiological control systems, Examples - Art of modeling - Linear systems - Mathematical Modeling, System properties- Resistance, Compliance - Models with combination of elements - Muscle model - Maxwell, Voigt Model - Linear physiological models - Distributed versus lumped parameter models - Mathematical tools for representation of physiological systems - SIMULINK model of physiological systems

UNIT II - STATIC ANALYSIS

Static Analysis, Open loop versus closed loop physiological systems - Determination of Steady state operating point - Open loop and closed loop analysis of cardiac model - Determination of steady state operating point of cardiac model - Regulation of glucose insulin model - Chemical regulation of ventilation - Dye dilution model - Steady state analysis using SIMULINK

UNIT III - TIME DOMAIN ANALYSIS

Time domain analysis - Introduction to first order and second order model - Respiratory mechanics - open loop and closed loop model of lung mechanics - First order model - impulse and step response - Second order model - Impulse response - undamped, under damped, critically damped, and over damped behavior - Method of obtaining step response from impulse response - Transient response descriptors - Model of neuromuscular reflex motion - Transient response analysis using MATLAB

UNIT IV - FREQUENCY ANALYSIS

Frequency response analysis - response to sinusoidal inputs - Closed loop and open loop response - Relationship between transient and frequency response - Graphical representation of Frequency response - Bode plot - Nicholas chart - Nyquist plots - Pupillary Retinal system - Frequency response analysis using MATLAB - Simulink

UNIT V-MODELING

Identification of physiological control systems - Parametric and non-parametric identification methods - Identification of closed loop systems - minimal model of blood glucose regulation - Model based approaches - Neuro-physiological based approaches - Neural network for control systems - Introduction -Supervised and direct inverse control - Human thermal system model - Pharmacokinetic modeling

REFERENCES

1 Michael C K, Khoo, "Physiological Control Systems - Analysis, Simulation and Estimation", Prentice Hall of India Private Ltd., New Delhi, 2001.

2 Joseph D, Bronzino, "The Biomedical Engineering Handbook", CRC Press, 3rd edition, 2006

3 Claudio Cobelli, Ewart Carson, "Introduction to Modeling in Physiology and Medicine", Academic Press, 2008.

BTBME606C ELECTIVE-VI
ROBOTICS AND AUTOMATION IN MEDICINE

Course Objectives:

- To study about the basic concepts of robots and types of robots.
- To study about manipulators, actuators and grippers.
- To study about various types of sensors and power sources
- To study the various applications of robot in the medical field.

Course Outcomes:

1. To provide the basic knowledge on design, analysis, control and working principle of robotics in surgery, rehabilitation and drug delivery (Nano robot).

UNIT I - INTRODUCTION OF ROBOTICS

Introduction to Robotics and its history, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Automation, Mechanisms and movements, Dynamic stabilization- Applications of robotics in medicine

UNIT II - ACTUATORS AND GRIPPERS

Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, Design consideration in vacuum and other methods of gripping, PD and PID feedback actuator models,

UNIT III - MANUPULATORS & BASIC KINEMATICS

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

UNIT IV - POWER SOURCES AND SENSORS

Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors, laser range finder,

variable speed arrangements, Path determination - Machinery vision, Ranging - Laser- Acoustic, Magnetic fiber optic and Tactile sensor

UNIT V - ROBOTICS IN MEDICINE

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric-, and General- Surgery, Gynecologic Surgery, General Surgery and Nano robotics.

REFERENCES

1. Nagrath and Mittal, "Robotics and Control", Tata McGraw-Hill, First edition, 2003.
2. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and Sons, First edition, 2008.
3. Fu.K.S, Gonzalez.R.C., Lee, C.S.G, "Robotics, control", sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008.
4. Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki and Sebastian Thurn, *"Principles of Robot Motion: Theory, Algorithms, and Implementations",* Prentice Hall of India, First edition, 2005.
5. Philippe Coiffet, Michel Chirouze, *"An Introduction to Robot Technology",* Tata McGraw-Hill, First Edition, 1983.
6. Jacob Rosen, Blake Hannaford & Richard M Satava, *"Surgical Robotics: System Applications & Visions",* Springer 2011.
7. http://www.lapsurg.com.br/arquivos/books/medical_robotics12402am020100000000.pdf
8. Barbara Webb and Thomas Consi. R, *"BioRobotics: Methods & Applications",* Barbara Webb and Thomas Consi. R, AAAI Press/MIT Press, First Edition, 2001.
9. Constantinos Mavroidis, Antoine Ferreira, "Nanorobotics: Current approaches and Techniques", Springer 2011.

BTBM710 MINI PROJECT

Course Objectives:

- To gain knowledge in linear models of biological systems.
- To learn about non linear equations in biomedical engineering.
- To gain knowledge on probability concepts.
- To learn the methods of studying correlation and regression.
- To learn about ANOVA.

Course outcomes:

1. To develop an understanding of the methods of probability which are used to model engineering problems.
2. To develop an understanding of the methods of statistics which are used to model engineering problems.

EMESTER VII

BTBM701 BIOMEDICAL CONTROL SYSTEMS

Course Objectives:

- To understand the system concepts and different mathematical modeling techniques applied in analyzing any given system.
- To analyze the given system in time domain and frequency domain.
- To study the techniques of plotting the responses in both domain analyses using various plots.
- To learn the concepts of physiological modeling
- To apply these analysis to understand the biological systems

Course Outcomes:

1. To gain basic knowledge about the concepts of control systems and study its application in physiological modeling.

UNIT I - CONTROL SYSTEM MODELLING

System concept, Differential Equations, Transfer functions, Modeling of electrical systems Translational systems, Rotational mechanical systems, Electro-mechanical systems, physiological systems, Modeling block diagram, reduction methods, Signal flow graphs

UNIT II - TIME RESPONSE ANALYSIS

Time domain specifications, step and impulse response analysis of first order and second order systems, steady state errors, stability, Routh-Hurwitz criteria, Root locus techniques, Construction of root locus stability, Dominant poles applications of Root locus diagram

UNIT III - FREQUENCY RESPONSE ANALYSIS

Frequency response Bode plot, Nyquist plot, Nyquist stability criterion, Relative stability, Gain margin, phase margin, bandwidth magnitude plots, Polar plot, Nichol"s chart, Constant M and N circles.

UNIT IV - PHYSIOLOGICAL CONTROL SYSTEM

Introduction to physiological control systems, Human Thermal system,Neuro muscular system occulomotor system, Respiratory system, difference between engineering and physiological control systems, generalized system properties.

UNIT V - MODELLING OF PHYSIOLOGICAL SYSTEMS

Modeling of human movements, parameter estimation, linearizing, Block diagram representation of the muscle stretch reflex, Linear model of respiratory mechanics, model of chemical regulation of ventilation ,linear model of muscle mechanics, model of regulation of cardiac output , model of Neuromuscular reflex, motion models with combination of system elements simulation .

TEXTBOOKS

1. Nagrath J, and Gopal M, "Control System Engineering", New Age international Publishers, 5th Edition, 2007.
2. Gopal M, "Control System - Principles and Design", Tata McGraw Hill, 2nd Edition, 2002.

REFERENCES

1. Michael C K, Khoo, *"Physiological control systems"* IEEE press, John Wiley & SonsInc, First edition, 2000.

BTBM702 VIRTUAL INSTRUMENTATION DESIGN FOR MEDICAL SYSTEMS

Course Objectives:

To impart adequate knowledge on Virtual Instrumentation for acquisition and analysis of signals in medical system

Course Outcomes:

1. Learner will be able to educate about the Basic concepts of VI
2. Learner will be able to make them understand the programming concepts of VI.
3. Learner will be able to provide an insight to various Common Instrument Interface.
4. Learner will be able to enable them to implement VI in medical systems
5. Learner will be able to impart knowledge on various analysis tools

UNIT I -INTRODUCTION TO VIRTUAL INSTRUMENTATION (VI)

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 VI

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

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 INSTRUMENT INTERFACE

Current loop:4-20mA,60mA, RS232, RS422, RS485, General purpose interface bus(GIPB) .Virtual Instrument Software Architecture (VISA), Universal serial port bus(USB), Peripheral computer interface (PCl), VME extensions for instrumentation (VXI), PCI extensions for Instrumentation (PXI), Personal Computer Memory Card International Association (PCMCIA), Signal conditioning extension for instrumentation (SCXI).

UNIT V - ANALYSIS TOOLS AND APPLICATIONS OF VI

Fourier transform, Power spectrum, Correlation, Windowing, filtering, Oscilloscope, Waveform generator, Multi-channel data acquisition using LABVIEW, ECG acquisition for long term monitoring of heart rate using VI

TEXTBOOKS

1. Gary Jonson, "Labview Graphical Programming", Second Edition, McGraw Hill, New York, Fourth edition 2006.
2. Lisa K wells & Jeffrey Travis, "Labview for everyone", Prentice Hall Inc, New Jersey, First edition 1997.

REFERENCES

1. Gupta S J, Gu.pta P, "PC interfacing for Data Acquisition & Process Control", Instrument Society of America, Second Edition, 1994.
2. Technical Manuals for DAS Modules of Advantech and National Instruments.

BTBM703 REHABILITATION ENGINEERING

Course Objectives:

To learn the basic concepts of rehabilitation engineering and assist devices and to understand the importance of biomedical engineering in rehabilitation.

Course Outcomes:

1. Learner will be able to study basics of Rehabilitation Engineering
2. Learner will be able to learn the design of Wheel Chairs
3. Learner will be able to gain knowledge of the recent developments in the field of rehabilitation engineering.
4. Learner will be able to understand various assistive technology for vision & hearing
5. Learner will be able to study various orthotic & prosthetic devices

UNIT I - INTRODUCTION TO REHABILITATION ENGINEERING

Introduction to Rehabilitation Engineering - PHAATE model - Clinical practice of rehabilitation Engineering - Low technology tools - Service delivery – Universal design - Design based on human ability - Standards for assistive technology -Test for best design

UNIT II - WHEEL CHAIR

Seating Assessment - Interventions in seating system - Biological aspects of tissue health - Support surface classification - Manual wheelchairs – Electric power wheelchairs - Power assisted wheelchairs - Wheel chair standards & tests- Wheel chair transportation

UNIT III - ORTHOTIC & PROSTHETIC DEVICES

Anatomy of upper & lower extremities - Classification of amputation types, Prosthesis prescription - Components of upper limb prosthesis - Fabrication of prosthesis - Components of lower limb prosthesis - Orthoses: It"s need and types -Lower extremity- and upper extremity- orthoses - Slints - materials used

UNIT IV - ASSISTIVE TECHNOLOGY FOR VISION & HEARING

Anatomy of eye, Categories of visual impairment - Cortical & retinal implants - Auditory Information Display - Blind mobility aids - reading writing & graphics access, Orientation &

navigation Aids - Anatomy of ear - hearing functional assessment - Surgical and non surgical hearing aids - Assistive technology solutions for hearing Tactile - Information Display

UNIT V - ADVANCED APPLICATIONS

Functional Electrical stimulation - Robots in rehabilitation - Rehabilitation in sports -Daily living aids - Assistive technology for dyslexia - Computer & internet access for challenged people - Neural engineering in rehabilitation engineering - Role of biomedical engineering in rehabilitation

TEXTBOOKS

1. Rory A, Cooper, Hisaichi Ohnabe, Douglas A, Hodson, "An Introduction to Rehabilitation Engineering", CRC Press, First edition, 2006.

REFERENCES

1. Marion A Hersh, Michael A, Johnson, "Assistive Technology for Visually impaired and blind people", Springer Publications, First edition, 2008.
2. Suzanne Robitaille, "The illustrated guide to Assistive technology and devices-Tools and gadgets for living independently", Demos Health Newyork, First edition, 2010.

BTBME704A ELECTIVE-VII

NSF Course III

Course Objectives:

- To gain knowledge in linear models of biological systems.
- To learn about non linear equations in biomedical engineering.
- To gain knowledge on probability concepts.
- To learn the methods of studying correlation and regression.
- To learn about ANOVA.

Course outcomes:

1. To develop an understanding of the methods of probability which are used to model engineering problems.
2. To develop an understanding of the methods of statistics which are used to model engineering problems.

TEXTBOOKS

1. Geoddes L.A, and Baker L.E, "Principles of Applied Biomedical Instrumentation", John Wiley, 3rd Edition, 1975, Reprint 1989.
2. Khandpur R.S, "Hand-book of Biomedical Instrumentation", Tata McGraw Hill, 2nd Edition, 2003.
3. Leslie Cromwell, Fred J, Weibell, Erich Pfeiffer A, "Biomedical Instrumentation and Measurement", Prentice-Hall India, 2nd Edition,1997.

REFERENCES

1. Stuart MacKay R, "Bio-Medical Telemetry: Sensing and Transmitting Biological Information from Animals and Man", Wiley-IEEE Press, 2nd Edition, 1968.
2. John G, Webster, "Medical Instrumentation application and design", JohnWiley, 3rd Edition, 1997.

3. Carr Joseph J, Brown, John M, "Introduction to Biomedical equipment technology", John Wiley and sons, New York, 4th Edition, 1997.

BTBME704B ELECTIVE-VII

ADVANCED MEDICAL IMAGING SYSTEMS

Course Objectives:

- To introduce the students to advanced medical imaging techniques enabling the students to work professionally in the biomedical engineering sector and other medical imaging related industry in designing systems, components, products or processes to meet desired needs of these industries in health care wing.

Course outcomes:

1. Learner will be able to study about fluoroscopic imaging techniques and components.
2. Learner will be able to learn about the principle, reconstruction ,artifacts with CT imaging
3. Learner will be able to understand the basics and advancement in fMRI
4. Learner will be able to learn about microwave and infrared medical imaging modalities.
5. Learner will be able to understand the concepts of radioisotope and nuclear imaging

UNIT I - FLUOROSCOPY

Fluoroscopic imaging chain components - Characteristics of Image intensifier performance - Modes of operation - Image quality - Radiation dose – Fluoroscopic suites - Peripheral equipment - Optical coupling - Video cameras

UNIT II-COMPUTED TOMOGRAPHY

Basic Principles - Geometry and Historical Development - Detectors and Detector Arrays - Details of Acquisition - Tomographic Reconstruction - Digital Image Display - Radiation Dose, Image Quality - Artifacts - Optical Tomography

UNIT III-fMRI

Introduction to fMRI - Basics of MRI Signal, Tissue contrast and spatial localization - Neuronal activity and Hemodynamics - BOLD fMRI - SNR in fMRI - Experimental design - fMRI statistics land 2 - Advanced fMRI.

UNIT IV - MICROWAVE AND INFRARED IMAGING

Introduction, Electromagnetic scattering - Elecromagnetic inverse scattering problem - Imaging configuration - Model approximations – Qualitative reconstruction methods - Microwave imaging apparatus - Infrared imaging- Thermography - Clinical applications of thermography - liquid crystal thermography.

UNIT V - RADIO ISOTOPE IMAGING AND NUCLEAR MEDICINE

Radio nuclides for imaging: Cyclotron-, Nuclear reactor-, and Generator production - Rectilinear-, and linear scanners- SPECT- PET - Gamma Camera - Comparison of tomographic techniques - Radiation dosimetry- Radiation protection.

TEXTBOOKS

1. Khandpur R S, "Hand-book of Biomedical Instrumentation", Tata McGraw Hill, 2nd Edition, 2003.

2. William hendee R, Russell Ritenour E, "Medical imaging physics", Fourth Edition, 2002.

REFERENCES

1. Stephan Ulmer, Olav Jansen, "FMRI: Basics and Clinical Applications", springer, first Edition,2010.

2. Matteo Pastorin , "Microwave imaging", John Wiley and Sons ,first edition , 2010.

BTBME704C ELECTIVE-VII

ADVANCED DIAGNOSTIC AND SURGICAL EQUIPMENT'S

Course Objectives:

- To gain basic knowledge about ICU equipment, neonatal equipment and safety measures for bio medical equipment.
- To give a complete exposure to working of advanced surgical and diagnostic lab equipment.

Course Outcomes:

1. Learner will be able to study the various ICU and neonatal equipment
2. Learner will be able to understand concept of the Neurological equipment
3. Learner will be able to study about Diagnostic of lab equipment
4. Learner will be able to study about surgical O.T equipment
5. Learner will be able to understand the surgical of scopy and diathermy equipment

UNIT I - ICU EQUIPMENTS AND NEONATAL EQUIPMENT

Oxygen concentrators - Capnographs monitoring systems - cardiac monitor, multipara monitor - Advanced defibrillators -internal and external – Intermediate level of suction apparatus - Laryngoscope - Advance level of radiant warmer, phototherapy units - Doppler fetal heart rate device (handheld type), Fetal Tocography - C.T.G, Baby Incubator, Neonatal ventilator

UNIT II - DIAGNOSTIC NEUROLOGICAL EQUIPMENTS

Stereo toxic unit- depth recording system-dot scanners- transcutaneous nerve Stimulator-anesthesia monitor - EEG controlled anesthesia- bio-feedback equipments, Spinal reflex measurements.

UNIT III - DIAGNOSTIC LAB EQUIPMENTS

Basic Blood gas analyzer - Photo meter and spectro photometer - Microtome, osometer, Lab freezer - PH meter, Optical microscope - Water bath types, Centrifuge (table), Shakers, Lab,

laminar air flow units - Lab precision balances, Pippets, Washers, Incubator and Heating unit centrifuge (Flour) – Electrophoresis systems, tissue embedding equipment - Ambulance setup

UNIT IV - SURGICAL EQUIPMENTS

Electrosurgical units, Warmer (Blood and Patient) - tourniquet, insufflators, irrigation unit - Operating microscope - arthroscopic, Operation Theater (OT): Lights, and Patient"s tables - Flow meters (gas & blood), sterilizing units (auto clave), Surgical driller - Sterilizing producers, manifold unit - Central supply of air.

UNIT IV - SURGICAL SCOPY ANDDIATHERMY EQUIPMENTS

Laparoscope, Gastro scope, endoscopes -light sources. Bronchoscope: Video processors, Camera, and 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.

TEXTBOOKS

1. Albert M, Cook and Webster J G, "Therapeutic Medical Devices", Prentice Hall Inc., New Jersey, 1982.
2. Geddes L A and Baker L E, "Principles of Applied Biomedical Instrumentation", John Wiley, 3rd Edition, 1975, Reprint 1989.
3. Khandpur R S, "Hand-book of Biomedical Instrumentation", Tata McGraw Hill, 2nd Edition, 2003.

REFERENCES

1. Leslie Cromwell, Fred J, Weibell, Erich A, Pfeiffer, "Biomedical Instrumentation andMeasurements", Prentice-Hall India, 2nd Edition,1997.
2. John G, Webster, "Medical Instrumentation application and design", JohnWiley, 3rd Edition, 1997.
3. Fein Berg B N, "Applied Clinical Engineering", Prentice Hall Inc., New Jersey, 1986.

BTBME704C ELECTIVE-VII

HOSPITAL RADIO PHARMACY

Course Objectives:

To understand the ability in performing the manipulative and record keeping functions associated with the compounding and dispensing of Radiopharmaceuticals in Hospital

Course outcomes:

1. Learner will be able to provide students with knowledge of nuclear medicine centers , setting up and running radio-pharmacy service
2. Learner will be able to know about the quality control and role of PET in nuclear medicine
3. Learner will be able to gain knowledge about the radiation safety and radiation protection
4. Learner will be able to understand the concept of procedures and operations relating to the reconstitution, packaging and labeling of radiopharmaceuticals
5. Learner will be able to provide clear boundaries for different levels of radio-pharmacy operations with a view for more definitive advice on staff qualifications, training and facilities

UNIT I - TYPES OF RADIATION, & RADIONUCLIDE

Introduction to radiation, Practical types of radiation, Radioactive component - importance of shielding - containers in operations - importance of distance in radiation interaction with matter - Radionuclide calibrators, Practical calibrator geometry - Radiation safety - Production of radionuclides- Tc-99m generator - Mathematics in radio-pharmacy (RP) practice.

UNIT II - OPERATION & STAFFING

Radiopharmacy operations - Good radio-pharmacy practice in hospital radio- pharmacy - Design of facilities - Introduction to diagnosis with radio-pharmacy - Standard operating procedures (SOP)

UNIT III - GUIDANCE FOR OPERATIONAL LEVEL 1A, 1B, 2A, 2B

Guidance for Operational Level 1a, 1b, 2a, and 2b: Staff and Training, facilities, operations, record keeping, quality control- Self assessment or audit

UNIT IV - GUIDANCE FOR OPERATIONAL LEVEL 3A, 3B, 3C

Guidance for Operational Level 1a, 1b, 2a, and 2b: Staff and Training, facilities, operations, record keeping, quality control- Self assessment or audit

UNIT V - QUALITY CONTROL & RADIOPHARMACOLOGY LOCALIZATION

MECHANISMS

Quality control of radiopharmaceuticals - RP Licensing systems and role of pharmacopoeia - Practical working a RP monograph - Sterility test, pyrogen test - Procurement of radiopharmaceuticals - Infection and inflammation imaging - Radio-labeling of white blood cells (WBC) and red blood cells (RBC).

REFERENCES

1. Anthony Theobold, "Textbook of Radio pharmacy", Pharmaceutical Press, Fourth Edition, 2010.

2. Charles B, Sampson, "Textbook of Radio pharmacy: Theory and Practice", Gordon and Breach Science Publishers, Third Edition, 1999.

TEXTBOOKS

1. "Competency Based Hospital Radio pharmacy Training", International Atomic Energy Agency, Vienna, 2010.

2. "Operational Guidance on Hospital Radio pharmacy: A Safe and Effective approach", International Atomic Energy Agency, Vienna, 2008.

3. Ellis B L, Sampson C B, "Radiolabelling of blood cells - Theory and Practice", Gordon and Breach Science Publishers, Third Edition, 1999.

BTBME705A ELECTIVE-VIII

HOME MEDICARE TECHNOLOGY

Course Objectives:

- To provide the basics of home Medicare and its clinical applications in recent telehealth technology.

Course outcomes:

1. To make them understand about basics of home Medicare system
2. To impart the knowledge about the Home Medicare in various clinical application
3. To gain knowledge in design of home care devices
4. To understand the various aspects that influence safety, quality and effective home medicare
5. To gain in-depth knowledge about the advances in healthcare technologies and wireless technology related to healthcare system

UNIT I - INTRODUCTION TO HOME MEDICARE (9Hours)

Home health care – purpose – legal and ethical aspects- Organisation of home care system- Historical development of home care- Environmental influences on home care-Home care organisation- Home care nursing practice-Role of home care nurse and orientation strategies- Infection control in home -Patient education in home.

UNIT II - WORKING WITH CLIENTS (9Hours)

Basic human needs – communication and interpersonal skills – caregiver observation, recording and reporting, confidentiality. Working with elderly – aging and body systems. Working with children – need for home care. Mobility – transfers and ambulation, range of motion exercises, skin care and comfort measures.

UNIT III – MEDICAL DEVICES AT HOME (9Hours)

Medical devices at home – User centered design and Implementation – Co-design with old users – device types – user issues. Ethical and legal issues. Infant monitors, medical alert services, activity monitors.

UNIT IV - ADVANCEMENT IN MEDICAL TECHNOLOGIES (9Hours)

Advances and trends in health care technologies-Driver impacting the growth of medical Technologies- Impact of Moore"s law of medical imaging- E-health and personal healthcare- Defining the future of health Technology- Inventing the future tools for self health- Future of nano fabrication molecular scale devices- Future of telemedicine -Future of medical computing.

UNIT V - WIRELESS TECHNOLOGY (9Hours)

Wireless communication basics- Types of wireless network, Body area network- Emergency rescue- Remote recovery- General health assessments Technology in medical information processing- Future trends in healthcare technology.

TEXT BOOKS

1. Robyn Rice, "Home care nursing practice: Concepts and Application", 4th edition, Elsevier, 2006.

2. LodewijkBos, "Handbook of Digital Homecare: Successes and Failures", Springer, 2011.

REFERENCES

1. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph D. Bronzino,"Clinical Engineering", CRC Press, 2010.

2. Kenneth J. Turner, "Advances in Home Care Technologies: Results of the match Project", Springer, 2011.

BTBME705B ELECTIVE-VIII

DESIGN & DEVELOPMENT OF MEDICAL DEVICES

Course Objectives:

This course will introduce students with basics of design,construction and development process of devices which are used in medical, clinical or laboratory practice

Course outcomes:

1. To understand about basic design of medical device.
2. To study in detail about data acquisition system used in medical device
3. To study the minimally invasive device and technique used in medical devices
4. To study in detail about system description of diagnostic equipment.
5. To study in detail about system description of therapeutic equipments and various implants

UNIT I-INTRODUCTION TO MEDICAL DEVICE (9 hours)

Define medical device, Classification of medical device, Medical device vs medical instrumentation, Origin of bio-potential, Physiological signal, Human machine interface ,Input output and control signal, Data acquisition, Sensor, Amplification, Medical electrical stimulator.

UNIT II- MINIMALLY INVASIVE DEVICE AND TECHNIQUE (9 hours)

Laparosopic instrumentation, surgical instrumentation in ophthalmology Phacoemulsification: Instrument and system-Vitrorectomy: Instrument and system-Human machine interface.

UNIT III-SYSTEM DESCRIPTION OF DIAGNOSTIC EQUIPMENT (9 hours)

Patient monitoring system, ECG, EEG, Blood pressure monitor, Digital stethoscope, Thermometer, System description and diagram of pulse oximeter, optical fiber optics for circulatory and respiratory system measurement.

UNIT IV-SYSTEM DESCRIPTION OF THERAPEUTIC EQUIPMENT (9 hours)

Pacemaker, External cardiovector defibrillator, Implantable cardiovector defibrillator, Deep brain stimulation , Functional electrical stimulator (FES),Hemodialysis delivery system, Mechanical ventilator.

UNIT V- SYSTEM DESCRIPTION OF VARIOUS IMPLANT AND PROSTHESIS

(8 hours)

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

TEXTBOOKS

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 DekkerAG,2nd edition 2005.

REFERENCES

1.Anthony Y. K,Chan, "Biomedical device technology: principles and design",Charles Thomas, 2008.

2.Theodore R,Kucklick, "The Medical Device Ramp-D Handbook", Taylor &Francis Group LLC, 3rd edition 2013.

3.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

BTBM709 INDUSTRIAL TRAINING-III

(Training to be undergone after VI Semester)

Course Objectives:

- To provide hands-on experience at site where biomedical equipment are manufactured and utilized (Hospitals).

Course outcomes:

1. Learner will be able to gather a first hand experience on usage of various biomedical equipment.
2. Learner will be able to get familiar with various medical imaging techniques.
3. Learner will be able to gain some practical experience in servicing the equipment.

INDUSTRIAL TRAINING III

Students have to undergo two weeks practical training in biomedical equipment manufacturing companies or hospitals. At the end of the training student will submit a report as per the prescribed format to the department.

SEMESTER VIII

BTBM801 Biomedical Microsystems

Course Objectives:

- To understand various fabrication technology for MEMS devices.
- To apply the knowledge of MEMS in Biomedical field.
- To understand recent advancements in Biomedical Engineering for a successful career in the area of nanotechnology.

Course Outcomes:

A learner will be able to

1. Use the knowledge of MEMS to develop various miniaturized biomedical devices.

UNIT-I BASICS OF MINIATURIZATION & MATERIALS

Dimensional effect on engineering systems ,Clean room classification ,Scaling Laws in Miniaturization ,MEMS & Micro system products ,Substrates and Wafers ,Properties of Silicon Compounds SiO2, Si3N4, Polysilicon, Amorphous silicon ,Polymers: Dielectric polymers, Conducting polymers, and piezoelectric polymers

UNIT-II MEMS FABRICATION PROCESSES

Fabrication techniques in MEMS: Bulk micromachining, Surface micromachining, and LIGA Cleaning processes: RCA, Piranha Deposition processes for metals: e-beam evaporation,thermal evaporation and DC Sputter, Deposition processes for dielectrics: Physical (RF Sputter) and Chemical Techniques (CVD: APCVD, LPCVD, PECVD, and HWCVD). Polymers coating techniques: spinning, spraying and electrodeposition , Photolithography: light sources (UV, DUV, and EUV), photoresist, mask design and fabrication using EBL, dark and bright field photo-mask, different projection systems in lithography, detailed study of lithography process, study of fabrication processes like optical grating structure, SiO2 cantilever , SiNx cantilever and

basics of EBL ,Etching Processes : Dry (RIE, DRIE) and wet etching Doping – ion implantation and diffusion ,Soft lithography: Micro contact Printing, Imprinting or hot embossing, and Replica Molding Surface characterization techniques: AFM, SEM, Profilometer, Elipsometer, Fluorimeter

UNIT-III MICRO TOTAL ANALYSIS SYSTEMS (μTAS)

Basic block diagram: importance of μ-TAS ,Flow techniques in μ-fluidics: pressure driven force, electro-kinematics; electro-osmosis, electrophoresis, dielectrophoresis ,Components in μ-TAS: Micropump, microvalves, microchannels ,μ-TAS: separation and mixing techniques fabrication of micro-channels: SU8 channel, glass channel, silicon channel

UNIT-IV MICRO/ NANO BIOSENSORS

Biosensor: definition, block diagram and working ,Classification based on the basis of detection techniques: Electric ,Magnetic, Optical, Thermal, Mechanical, and Chemical. Basic steps involved in the development of biosensors: surface modification, immobilization, integration with transducer

Examples: (i) Design, fabrication of SiO cantilever for antibody detection, (ii) Design,fabrication of Optical waveguide biosensor, (iii) Microfluidics based biosensor

UNIT-V DRUG DELIVERY DEVICES

Overview of drug delivery systems, Types of drug delivery systems, Different parts of drug delivery system, MEMS based drug delivery systems: Implantable drug delivery systems (IDDS), Micro needles and its fabrication, Micro particles for oral drug delivery.

UNIT-VI MICROSYSTEM PACKAGING

Importance of packaging ,Packaging materials ,Packaging techniques ,Wafer bonding

TEXTBOOKS

1. MEMS & Microsystems: Design, Manufacture, and Nanoscale Engineering, 2nd Edition

Tai-Ran Hsu, ISBN: 978-0-470-08301-7

2. MEMS and Microsystems: Design and Manufacture," mcgraw-Hill, Boston, 2002 (ISBN

0-07-239391-2).

REFERENCES

1. "Fundamentals of Microfabrication" Marc Madou, by, CRC Press, 1997.Gregory Kovacs,

2. "Fundamentals of BioMEMS and Medical Microdevices", Steven S. Saliterman, (SPIE Press Monograph Vol. PM153 by Wiley Interscience

3. "Microsystem Technology", W. Menz, J. Mohr, 0. Paul, WILEY-VCH, ISBN 3-527-29634-4

4. "Electro Mechanical System Design", James J. Allen, Taylor & Francis Group, LLC, ISBN-0-8247-5824-2, 2005

5. "MICROSYSTEM DESIGN",Stephen D. Senturia, KLUWER ACADEMIC PUBLISHERS, eBook ISBN: 0-306-47601-0

6. "Introduction to Microfabrication", Sami FranssilaJohn Wiley & Sons Ltd, ISBN 0-470-85106-6

7. "Microelectromechanical Systems", Nicolae Lobontiu, Ephrahim Garcia, KLUWER ACADEMIC PUBLISHERS, eBook ISBN: 0-387-23037-8

8. "BIOMEDICAL NANOTECHNOLOGY", Neelina H. MalschCRC PRESS, Taylor and Francis Group, ISBN 10: 0-8247-2579-4

BTBM802 BIOPHOTONICS

Course Objectives:

- To educate about the various interaction mechanisms of light with matter.
- To make them understand the working principles of optical imaging systems.
- To provide an insight to various biosensors
- To gain in-depth knowledge about flow cytometer
- To enable them to understand the importance of phototherapy in treatment of diseases

Course outcomes:

1. Learner will be able to impart adequate knowledge on various optical systems used in sensing and Imaging of biological elements.

UNIT I - LIGHT - MATTER INTERACTION & PRINCIPLE OF OPTICS

Light matter interaction: Interaction of light with bulk matter- Types of spectroscopy: Electronic absorption-, Electronic luminescence-, Vibration-, and Fluorescence- spectroscopy.

UNIT II - BIO-IMAGING: PRINCIPLES AND TECHNIQUES

Introduction of optical imaging, Types of microscopy: Transmission-, Fluorescence-, Scanning- and Multi-photon- microscopy- Advantages and disadvantages of optical imaging- Applications of optical imaging

UNIT III - OPTICAL BIOSENSORS

Principles of Optical biosensing, Immobilization of bio-recognition elements, Types of optical biosensor: Fiber optic-, Planar waveguide-, Evanescent-, Interferometric-, and Surface plasmon resonance- biosensor- Advantages and disadvantages- Applications

UNIT IV - FLOW CYTOMETRY

Flow cytometry: Basis, Components, and Flourochromes- Data manipulation and presentation

UNIT V - PHOTODYNAMIC THERAPY

Photodynamic therapy: Mechanism, and light irradiation- Photo-hemotheraphy- PUVA Technique- Applications.

TEXTBOOKS

1 Jurgen Popp, Valery V, Techin, Arthur Chiou, Stefen Heinemann, "Handbook of Biophotonics Vol 2: Photonics for Health Care", John Wiley & Sons, First Edition, 2012.

2 Paras N, Prasad, "Introduction to Biophotonics", John Wiley & Sons, First Edition, 2003.

REFERENCES

1 Harold Sackman, Brian Wilson, Valeri Viktorovich Tuchin, S. Tanev,Harold Sackman "Advances in Biophotonics", IOS Press, 2005.

2 Paras N Prasad, "Nanophotonics", John Wiley & Sons, First Edition, 2004.

BTBM804 BIOMECHANICS

Course Objectives:

- To study about the bone structure and cartilage
- To study the structure and functions of skeletal muscle
- To study the structure, movements, and loads applied to spine, shoulder and hip.
- To study about the fluid mechanic system applied to human body
- To understand the principles of mechanics that is used to analyze human movement.

Course outcomes:

1. Learner will be able to provide the knowledge of mechanical concepts as applied to human movement

UNIT I - FUNDAMENTALSOF MECHANICS

Newton"s law- mechanical behavior of bodies in contact, work, power and energy relationship - Angular kinematics of human movement-measuring angles, angular kinematic relationships -relationships between linear and angular motion - Angular kinetics of human movement-resistance to angular acceleration, angular momentum - Equilibrium and human movement-equilibrium, center of gravity, stability and balance - Kinematic concepts for human motion-forms of motion and joint movement terminology - Kinetic concepts for human motion-basic concepts related to kinetics .- mechanical loads on the human body .

UNIT II - BONE AND CARTILAGE

Bone structure & composition, blood circulation in bone - mechanical properties of bone, viscoelastic properties of bone - Maxwell & Voight models - viscoelastic properties of articular cartilage - Anisotropy and composite models for bone - Bone growth and development - Bone response to stress - Osteoporosis - causes, diagnosis, treatment - Elasticity and strength of bone .

UNIT III - BIOFLUID MECHANICS

Newtonian viscous fluid, non-viscous fluid - Rheological properties of blood - Structure and composition of blood vessel - Remodeling of blood vessels - Nature of fluids, Propulsion in fluid medium - Mechanical properties of arterioles, capillary vessels and veins - Bio-viscoelastic solids .

UNIT IV -MECHANICS OF SKELETAL MUSCLE

Structure of skeletal muscle -muscle fibers, motor units - Structure of skeletal muscle-fiber types, fiber architecture - Sliding element theory of skeletal muscle.- Skeletal muscle function - Contraction of skeletal muscle and hill"s three element model - Factors affecting muscular force generation - Muscular strength, power and endurance - Muscle injuries .

UNIT V - MECHANICS OF SHOULDER, SPINE AND HIP

Structure of the shoulder - Movements of shoulder complex - Loads on the shoulder - Structure of the spine - Movements of the spine - Muscles and loads on the spine - Structure and movements of the hip - Loads on the hip.

TEXTBOOKS

1. Fung Y C, Biomechanics: *"Mechanical Properties of Living Tissues",* Springer, 2nd edition, 1993.
2. Susan J Hall, *"basic biomechanics",* Tata Mcgraw hill, 4th edition, 2004.

REFERENCES

1. Webster J G, *"Medical instrumentation -Application & design",* John Wiley and Sons Inc., 3rd edition, 2003.
2. Schneck D J, and Bronzino J D, *"Biomechanics- Principles and Applications",* CRC Press, 2nd Edition, 2000.
3. Duane Knudson, *"Fundamentals of Biomechanics",* Springer, 2nd edition, 2007.

BTBM808 MAJOR PROJECT

Course Objectives:

1. 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.
2. To guide the students such a way that the students carry out a comprehensive work on the chosen topic which will stand them in good stead as they face real life situation.

Course outcomes:

1. Learner will be able to develop a model or simulation for real life situations related to Biomedical Engineering.
2. Learner will be able to perform the activity in groups to carry out a comprehensive work on the chosen topic.

PROJECT

Hardware/ Numerical/Theoretical research and development work is to be allotted. A maximum number of three students may be involved in each project. However the contribution of the individuals in the project should be clearly brought out. The combined project report is to be submitted as per the university regulations. A seminar has to be presented on the allotted topic. All the students involved in the project will be examined for their contribution.

Guidance is given to the students which will cover all the areas in Biomedical Engineering like Designing (Biomedical Equipments), Analysis, Simulation, Processing of bio-signals (ECG, EMG, EEG, EOG, ERG, etc.,) and medical images (MRI, CT,PET, etc.,) Alternately, a few research problems also may be identified for investigation and the use of laboratory facilities to the full extent may be taken as project work. Alternately, a student is encouraged to take an industrial project with any Biomedical Engineering Organization or Multi-specialty Hospital. A project report is to be submitted on the topic which will be evaluated.