SCHEME OF INSTRUCTION AND EVALUATION
B.E. (BIOMEDICAL ENGINEERING)

BE(Other branches) with MINORS In DEGREE with extra 18 credits in BME

Sl.No	Course Code	Course Name	Contact hours per week		Scheme of Examination		Credits	SEM
			L	P	CIE	SEE		
THEORY								
1.	MR 501 BM	Human Anatomy and Physiology	3	-	40	60	3	V
2.	MR 601 BM	Instrumentation for Medical Applications	3	-	40	60	3	VI
3.	MR 602 BM	Basic Diagnostic and Therapeutic Equipment	3	-	40	60	3	VI
4.	MR 701 BM	Medical Imaging Modalities	3	-	40	60	3	VII
5.	MR 702 BM	Materials for Medical Implants	3	-	40	60	3	VII
		PRACTICALS						
6.	MR 851 BM	Project Work	-	6	-	100	3	VIII
		TOTAL	**15**	**6**	**200**	**400**	**18**	

L-Lectures
T-Tutorials
P-Practicals
CIE-Continuous Internal Evaluation
SIE-Semester End Evaluation

MR 501 BM

Human Anatomy and Physiology

Instruction	3 Periods per week
Duration of University Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. To study systemic anatomy i.e., the structure and position of the systems in the human body like the respiratory, circulatory, digestive, urinary, reproductive, endocrine and nervous systems.
2. This course is designed such that the student is exposed to various mechanisms involved in the normal functioning of human body underlining the basic working principles of different biological processes with Engineering tools.

COURSE OUTCOMES:

1. Able to classify the various systems of human body and identifying their functionality
2. Able to understand musculoskeletal skeletal system and different joints
3. Able to understand nervous system and assess functionality of brain
4. Able to evaluate CVS by BP and heart rate
5. Able to perceive the importance of Respiratory System and identifying the need for ventilators

UNIT-I

Musculo-Skeletal System: Bones: Types with examples. Joints: Types with examples. Structure and Classification of synovial joint with examples. Muscular system. Types and locations. Structure of a skeletal muscle. Important muscle of limbs-location. Actions.
Smooth muscle, Cardiac Muscle, Skeletal muscle, Excitation-Contraction coupling, Sarcomere-Contractile Unit, Motor Unit.

UNIT-II

Nervous System: Classification into Central Nervous System (CNS), Peripheral Nervous System (PNS), Autonomic Nervous System (ANS).
Spinal cord. Subdivisions of brain. Base of brain with cranial nerve attachments. Brain stem, Cerebellum, Cerebrum, Diencephalon, Ventricular System, Special Senses.
Higher functions of Brain (Perception, Rule of special senses, Learning and memory), Cybernetics of living systems, Neuro-Endocrine Control System, Servo mechanism, Motor skills.

UNIT-III

Cardiovascular System: Heartchambers and heart valves. General plan of Circulatory System-major blood vessels, Systemic and pulmonary circulation. Conducting system of the Heart, Generation of ECG.

UNIT-IV

Respiratory system: Various parts of Respiratory System-Trachea, Bronchial tree, Lungs.Perfusion and Diffusion limited process, Ventilation, Alveolar, Physiological and anatomical shunts and dead spaces. Mechanism of Inspiration and Expiration.

UNIT-V

Urinary system: Parts of Urinary System. Kidneys, Ureter, Urinary Bladder and Urethra. Mechanism of filtration and urine formation.

Regulation of volume and composition of Body fluids, Clearance equations, Acid-Base Balance, regulation of Body Temperature. Hormonal regulation of Body functions.

Suggested Readings:

1. Gibson J, *Modern Physiology & Anatomy for Nurses*, Blackwell Scientific Publishers, 1981
2. 2.CharlesE.Tobin, *Basic Human Anatomy*, McGraw Hill, 1980.
3. Mount Castle, Textbook of Medical Physiology.
4. Best and Taylor, Physiological basis of Medical Practice.
5. John.Herbert Green, An Introduction to physiology, Oxford University Press, 1976 5
6. Gillain pocock, Christopher D. Richards, Human Physiology, The Basis of Medicine, Oxford University Press, 2004

MR 601 BM

INSTRUMENTATION FOR MEDICAL APPLICATIONS

Instruction	3 Periods per week
Duration of University Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

UNIT- I

Block diagram of a medical instrumentation system, Challenges faced with physiological measurements. Medical instrument specifications. Electrodes for biophysical sensing, medical surface electrode. Micro electrodes. Applications of biopotential electrodes.

UNIT-II

Signal acquisition, transduction, active vs passive sensors, sources of errors in sensors, Working principles andmedical applications of sensors and transducers- resistive, inductive, capacitive.

UNIT-III

Basic requirements for the display and recording of Biopotential signals. PMMC writing systems-Direct writing recorders and ink-jet recorders. Thermal writing. Array recorders-thermal and electrostatic recorders. Medical Oscilloscopes, Multibeam and Non-fade display systems, LCD, OLED systems.

UNIT-IV

Working principles, components and medical applications of Colorimeter, spectrophotometer, Flame photometer-Absorption & Emission photometry, Flurometry, Mass spectrophotometer, Electrophoresis Apparatus, Chromatograph.

UNIT-V

Working principles, components and medical applications of Nebulizer, Humidifiers, Suction apparatus. Fluid warmer, Fumigator, Oxygen concentrator. Oximeters, Automatic differential blood cell counters, Blood gas Analyzer.

Suggested Readings:

1. Webster J.G., *Medical Instrumentation Application and Design*. Houghton Mifflin, 2009.
2. Carr and Brown, *Introduction to Biomedical equipment technology*, 2011.
3. Khandpur R.S. *Hand Book of Biomedical Instrumentation*, Tata McGrawHill,2003.

MR 602 BM

BASIC DIAGNOSTIC AND THERAPEUTIC EQUIPMENT

Instruction	3 Periods per week
Duration of University Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

- To make the students understand the operating principles of a wide range of Biomedical Equipment.
- To familiarize the students with the operating principles of the equipment.
- To enable the students to gain knowledge on the applications of various medical equipment.

Course Outcomes: Upon completion of the course, the students will be able to

1. Assess use of electrical stimulation principles to overcome cardiac rhythm disturbances.
2. Comprehend the principles of Anesthesia machine, functions of respiratory equipment and ventilators and sterilization equipment.
3. Assess the need and operating principle of equipment used in audiometry, Neonatology and drug delivery.
4. Comprehend the principles of Hemodialysis machine,
5. Perceive the governing principles of surgical diathermy and radiotherapy

UNIT – I

Electrocardiography: Block diagram of ECG. Blood Pressure measurement: Components and working principle of sphygmomanometer. Direct and indirect methods of Blood Pressure measurements. Electromagnetic and Ultrasonic techniques of Blood flow measurement.

UNIT-II

Electroencephalography: EEG-Block diagram, 10-20 electrode placement. Resting rhythms. Evoked potentials and their measurement. Filters for EEG rhythm analysis.

Electromyography: Introduction to EMG signals. EMG-Block diagram and circuits. Electrodes and their placement. Nerve conduction velocity, determination using EMG, Stimulators for EMG recording.

UNIT – III

Cardiac Pacemakers: Types of arrhythmias,Pacemaker types-Asynchronous, Synchronous, External and implantable, Working principle, block diagram.

Synchronous/Demand Pacemaker: Modes of triggering-ventricular triggered and atrio-ventricular synchronized pacemaker, Programmable pacemaker, Microprocessor based implantable pacemaker, Rate responsive pacemaker.

Defibrillators: Need for Defibrillators, D.C. Defibrillator, Need for SynchronousDefibrillators, Automatic/Advisory External Defibrillators (AED), Implantable defibrillators.

UNIT – IV

Ventilators: Block diagram, Modes of ventilators, Types of ventilators-CPAP, BiPAP.

Heart lung Machine: Working principle. Components of heart lung machine. Functional details of Bubble, Thin Film and membrane-type of blood oxygenators.

UNIT – V

Haemodialyzers - Dialyzers, principle of dialyzers, Membranes of the haemodialyzers, Types of Dialysis and merits and demerits.

Lithotriptors: Principles and Applications, Need for Lithotriptor, First Lithotriptor Machine, Modern Lithotriptor Systems, Extra-corporeal shock-wave Therapy

Suggested Reading:

1. John G. Webster, "Medical Instrumentation-Application and Design", John Wiley and sons Inc., 3rd Ed., 2003.
2. Khandpur R.S., Hand Book of Biomedical Instrumentation, Tata Mc.Graw Hill Pub Co.Ltd., 2nd ed., New Delhi, 2016.
3. Joseph J. Carr ad John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education, 2001.
4. Harry Bronzino E, Handbook of Biomedical Engineering and Measurements, Reston, Virginia.
5. Joseph J.Carr and John M.Brown, Introduction to Biomedical equipment technology, John Wiley and sons, New York, 1997

MR 701 BM

MEDICAL IMAGING MODALITIES

Instruction	3 Periods per week
Duration of University Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

- To familiarize the students with various medical imaging modalities.
- To make learners understand the principles, detectors and operating procedures of X-ray, CT, MRI, ultrasound, PET and SPECT.
- To make the students learn the advantages, disadvantages and hazards of various medical imaging equipment.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:

1. Interpret the working principle and operating procedure and applications of X-ray equipment.
2. Understand the image reconstruction techniques and applications of CT.
3. Summarize the image acquisition and reconstruction techniques in MRI.
4. Comprehend the working principle, modes and medical applications of ultrasound imaging.
5. Examine the operation and applications of PET, SPECT and radio nuclide instrumentation.

UNIT-I

X ray Imaging: Electromagnetic spectrum, Production of X-rays, X-ray tubes- Stationary and Rotating Anode types, Block diagram of an X-Ray Machine, Collimators and Grids, Timing and Exposure controls. X-Ray Image visualization-Films, Fluorescent screens, Image Intensifiers.

UNIT-II

Computed Tomography: Basic principles, CT number scale, CT Generations. Major sub systems- Scanning system, processing unit, viewing unit, storage unit. Need and Principle of sectional imaging. Applications of CT - Angio, Osteo, Dental, Perfusion (Body &Neuro), Virtual Endoscopy, Coronary Angiography.

UNIT-III

Ultrasound Imaging: - Principles of image formation -Imaging principles and instrumentation of A-mode, B-Mode, Gating Mode, Transmission mode and M-mode. Basics of multi-element linear array scanners, Digital scan conversion.

Doppler Ultrasound and Colour Doppler imaging, Image artifacts, Biological effects, Ultrasound applications in diagnosis, therapy and surgery.

UNIT- IV

Magnetic Resonance Imaging: Principles of NMR imaging systems, Image reconstruction techniques-Relaxation processes, imaging/ pulse sequences, types of coils, biological effects and advantages of NMR imaging.

UNIT-V

Nuclear Medicine–Radioisotopes in medical diagnosis, Basic instrumentation- Radiation detectors, Pulse height analyzer, Rectilinear scanner, Gamma camera.Emission Computed Tomography (ECT), Principle and instrumentation of Single Photon Emission Computed Tomography(SPECT) and Positron Emission Tomography (PET).
Comparison of SPECT, PET and combined PET/ X-ray CT.

Suggested reading:

1. Khandpur R.S., *Handbook of Biomedical Instrumentation*, Tata McGraw Hill, 2016.
2. S Webb, "*The Physics of Medical Imaging*", Adam Highler, Bristol Published by CRC Press, 1988.
3. A C Kak, "*Principle of Computed Tomography*", IEEE Press New York, 1988.
4. Hykes, Heorick, Starchman, *Ultrasound physics and Instrumentation* MOSBY year book, 2nd Ed. 1992.
5. Stewart C.Bushong, *Magnetic Resonance Imaging- physical and biological principles*, MOSBY, 2nd Ed., 1995.

MR 702 BM

MATERIALS FOR MEDICAL IMPLANTS

Instruction	3 Periods per week
Duration of University Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

- To understand the medical device classes and regulatory efforts
- To understand the of national and international medical device regulations and standards
- To know about the patents and intellectual property rights.

COURSE OUTCOMES: Upon completion of the course, the student will be able to

1. Differentiate the medical devices under their respective classes.
2. Design medical products using different methodologies
3. Deliver the rules of Indian Medical Device Regulations-2017
4. Understand the product safety and legal issues
5. Apply the concepts in design of medical equipment.

UNIT 1

Biomaterial and its properties: Definition and need, Types of Biomaterials, Requirements of an ideal biomaterial, Biocompatibility. Characterization of materials – Mechanical, chemical, thermal, electrical, optical and other properties.

UNIT II

Materials used as biomaterials and their properties: Properties of metallic biomaterials – stainless steels, Cobased alloys, Ti and Ti–based alloys, Ni-Ti alloys. Properties of Ceramic biomaterials - Aluminum Oxides, Calcium Phosphate, Glass ceramics and Carbons. Properties of Polymeric biomaterials – Polyamides, Polyethylene, Polyacrylates, Polyvinyl Chloride.

UNIT-III

Tissue response to biomaterials and testing of biomaterials: Inflammation, wound–healing and foreign body response, systemic toxicity and hypersensitivity, Blood compatibility, Carcinogenicity, implant–associated infection. In-Vitro and In-Vivo assessment of tissue compatibility and testing of blood–material interaction.

UNIT-IV

Soft tissue replacements: Sutures, Surgical tapes and Staples, Tissue Adhesives, Percutaneous Devices, Artificial Skin, Maxillofacial implant, Ear and Eye Implants, Fluid Transfer Implants, Vascular Implants, Valve Implants,

UNIT-V

Hard tissue replacements: Wires, Pins, Screws, Fracture Plates-Cortical and Cancellous Bone Plates. Intramedullary devices, spinal fixation devices. Lower extremity Implants, Upper

Extremity Implants, Endosseous Tooth Implants–Subperiosteal and staple /Transosteal implants, Interface of orthopedic implants.

Suggested Reading:

1. Joon B. Park and Roderic S. Lakes, *Biomaterials – An introduction* Plenum Press, 2nd Edition,1992.
2. Buddy D. Ratner, Allan S. Hoffman, Frederick, J. Schoen and Jack E. Lemons, *BiomaterialsScience–An Introduction to materials in Medicine*, Academic Press, 1996.
3. John Enderle, Susan Blanchard and Joseph Bronzino, I*ntroduction to Biomedical Engineering*, 2nd Edition, Elsevier Academic Press, 2009.
4. Roger Narayan, *Biomedical Materials*, Springer, 2009. 5. NPTEL Video lecture: *Introduction to Biomaterials.*

MR 851 BM

PROJECT WORK

SEE:	100 Marks
Credits:	3

COURSE OBJECTIVES:

- To enhance practical and professional skills.
- To expose the students to industry practices and team work.
- To encourage students to work with innovative and entrepreneurial ideas

COURSE OUTCOMES: At the end of the course, students will be able to:

- Conceive a problem statement either from rigorous literature survey or from the requirements raised from need analysis.
- Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to solve the conceived problem.
- Write comprehensive report on mini project work and demonstrate effective written and oral communication skills

1. The aim of mini project is to develop solutions to real time problems by applying the knowledge and skills obtained in different courses, new technologies and current industry practices.
2. The mini-project is a team activity having 3-4 students in a team.
3. The mini project may be a complete hardware or a combination of hardware and software. The software part in mini project should be less than 50% of the total work.
4. Based on special lectures by faculty members or industry personnel/comprehensive literature survey/ need analysis, the student shall identify the title, and define the aim and objectives of mini-project.
5. The students are expected to identify specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within first 2 weeks of the semester to the mini project coordinator.
6. The students are expected to design, develop and test the proposed work as per the schedule.
7. Seminar schedule will be prepared by the coordinator for all the students from the 5^{th} week to the last week of the semester which should be strictly adhered to.
8. Each group will be required to:
   i. Submit a one-page synopsis before the seminar to the coordinator.
   ii. Give a 30-minute presentation followed by 10 minutes discussion.
   iii. Submit a technical write-up on the mini project work.
9. At least two teachers will be associated with the mini project to evaluate students for the award of sessional marks which will be on the basis of performance in all the 3 items stated above.
10. The seminar presentation and technical write-up (mini project report) should include:Problem definition and specification, Literature survey, Broad knowledge of available techniques to solve a particular problem, Planning of the work, preparation of bar (activity) charts, Presentation- oral and written.