UNIVERSITY COLLEGE OF MEDICAL EDUCATION
MAHATMA GANDHI UNIVERSITY
GANDHINAGAR, KOTTAYAM - 686008

REGULATIONS, SCHEME AND SYLLABUS
FOR THE DEGREE OF
MASTER OF APPLIED SCIENCE IN
BIOMEDICAL INSTRUMENTATION
OBJECTIVES OF THE COURSE

After the completion of the course, the candidate should be able to:

1. Handle the Biomedical Equipments at all levels used in Health care systems, from simple electronic design to highly sophisticated computerized equipments.
2. Supervise the operation and service of the equipments used in Medical field.
3. Guide specialists in various diagnostic and therapeutic procedures by acquiring sound knowledge of the functioning of Human body.
4. To undertake teaching and research in the Biomedical Engineering field.

NAME OF THE POST GRADUATE PROGRAMME

The name of the Master Degree programme shall be “Master of Applied Science in Biomedical Instrumentation” shall be abbreviated as M. App. Sc. (BMI).

Candidates for admission to the First semester of the Master of Applied Science in Biomedical Instrumentation Degree programme shall be required to have passed the Bachelor degree examinations with Electronics, Instrumentation, Physics or Mathematics as main or subsidiary from any of the University in Kerala or Universities recognized by Mahatma Gandhi University as equivalent there to are eligible to apply for the course provided they have secured minimum of 50% marks for the optional subjects with usual relaxations allowed for Scheduled Castes, Scheduled Tribes and other Backward Classes.

DURATION AND STRUCTURE OF P.G. PROGRAMME

The duration of the course shall be two years, consisting of 4 semesters with University examinations at the end of each semester.

The P.G. programme will consist of

(i) Core subjects
(ii) Practicals / Laboratory work
(iii) Project work
(iv) Seminars
(v) Hospital/Industry training as specified in the curriculum.

The Medium of Instruction, Examination, Seminar and Project reports will be in English.
The **Hospital/Industry Training** specified in the curriculum shall be of **10 days duration** at the end of **first semester**, **15 days at the end of second semester** and **one month duration** at the end of **third semester** of the course.

A candidate may however in certain cases be permitted to work on the **Project** in an Industry/ Hospital/ Research Organization on the recommendation of the Head of the Department/ Director. In such cases the project work shall be supervised jointly by a member of the Department of Biomedical Instrumentation Teaching faculty and an Engineer / Scientist from that organisation.

**ASSESSMENT PROCEDURE – EXAMINATIONS AND INTERNALS**

**I. UNIVERSITY EXAMINATIONS**

There shall be one end semester examination of 3 hours duration in each **Core subject**, conducted by the University.

In case of **Practicals**, an end semester Examination will be conducted by the University.

A **Viva-Voce** examination will be conducted by the University at the end of Final (4th) semester.

**II. SESSIONAL EXAMINATIONS**

In each **Core subject**, the Sessional examinations may be a combination of Attendance, Periodical tests, Assignments and Seminars conducted internally by the Department.

In case of **Practicals/Laboratory work**, Sessional Examinations are a combination of Attendance, Performance and Examinations conducted internally by the corresponding Department.

The **Seminar/ Project work** will be evaluated based on the Report, Presentation and Viva-Voce Examinations conducted internally.

At the end of each **Hospital/Industry Training** the candidate shall submit a Training Report along with certificate from the Organization where he / she have undergone training. The evaluation will be based on the Attendance, Training Report, Presentation and Viva-Voce Examination conducted internally. If a student is not securing separate minimum for Sessional examination, he/she shall be given a single redo chance before the commencement of the university examination provided he/she is having the minimum required attendance and the criteria for determining the Sessional assessment remaining the same.
MINIMUM REQUIREMENT FOR SUCCESSFUL COMPLETION

I. PASS MARK

The curriculum should be drawn up that the minimum pass marks for successful completion of M. App. Sc. (BMI) satisfy the following:

<table>
<thead>
<tr>
<th></th>
<th>University examinations</th>
<th>Sessional examinations</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Subject</td>
<td>45</td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>Practical/Laboratory Work</td>
<td>45</td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>Viva –Voce</td>
<td>75</td>
<td>150</td>
<td>-</td>
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<tr>
<td>Subject-Sessional (BMI-105)</td>
<td>-</td>
<td>-</td>
<td>25</td>
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<tr>
<td>Practical (BMI-3P2)</td>
<td>-</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>Seminar I&amp;II</td>
<td>-</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>Seminar III</td>
<td>-</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>Hospital Training (BMI-IP4,2P4)</td>
<td>-</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>Hospital Training (BMI-3P4)</td>
<td>-</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>Project Work (BMI-4P3)</td>
<td>-</td>
<td>-</td>
<td>75</td>
</tr>
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</table>

II. ATTENDANCE

A candidate who has attendance less than 80% will not be permitted to sit for the End Semester Examination in the Subject / Laboratory work in which the short fall exists.

CLASSIFICATION FOR THE AWARD OF MASTER OF APPLIED SCIENCE IN BIOMEDICAL INSTRUMENTATION

i) A candidate who completes the programme of study and secures a minimum pass mark in all subjects as specified will be declared to be qualified for the award of degree.

ii) A candidate who secures not less than 60% of Marks in the aggregate of all examinations in four semesters will be classified to have passed in First class.

iii) A candidate who secures not less than 75% of Marks in the aggregate in all four semesters will be declared to have passed in First class with Distinction.
**POWER TO MODIFY**

Not with standing all that have been stated above the academic council has the right to modify any of the regulations from time to time.

### SCHEME OF EXAMINATION

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Marks</th>
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</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td><strong>University Exams</strong></td>
<td><strong>Sessional Exams</strong></td>
<td><strong>Hours/week</strong></td>
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<tr>
<td>bmi-101</td>
<td>Engineering Mathematics</td>
<td>100</td>
</tr>
<tr>
<td>bmi-102</td>
<td>Introduction to Anatomy, Physiology and</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Biomedical Instrumentation</td>
<td></td>
</tr>
<tr>
<td>bmi-103</td>
<td>Electrical Technology</td>
<td>100</td>
</tr>
<tr>
<td>bmi-104</td>
<td>Electronic Devices &amp; Circuits</td>
<td>100</td>
</tr>
<tr>
<td>bmi-105</td>
<td>Communication and Soft Skills Development</td>
<td>50</td>
</tr>
<tr>
<td>bmi-1p1</td>
<td>Electronic Circuit Laboratory</td>
<td>100</td>
</tr>
<tr>
<td>bmi-1p2</td>
<td>Computer Applications Laboratory- I</td>
<td>100</td>
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<tr>
<td>bmi-1p3</td>
<td>Hospital/ Industry Training</td>
<td>50</td>
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<tr>
<td><strong>SEMESTER – II</strong></td>
<td></td>
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<tr>
<td>bmi-201</td>
<td>Biomedical Equipments – I</td>
<td>100</td>
</tr>
<tr>
<td>bmi-202</td>
<td>Digital Electronics and Integrated Circuits</td>
<td>100</td>
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<tr>
<td>bmi-203</td>
<td>Object Oriented Programming</td>
<td>100</td>
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<tr>
<td>bmi-204</td>
<td>Biophotonics and Non-Radiating Medical Imaging Techniques</td>
<td>100</td>
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<tr>
<td>bmi-2p1</td>
<td>Digital and Analog Circuits Laboratory</td>
<td>100</td>
</tr>
<tr>
<td>bmi-2p2</td>
<td>Computer Laboratory -II</td>
<td>100</td>
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<tr>
<td>bmi-2p3</td>
<td>Seminar - I</td>
<td>50</td>
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<tr>
<td>bmi-2p4</td>
<td>Hospital/ Industry Training</td>
<td>50</td>
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### SEMESTER – III

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Theory</th>
<th>Practical</th>
<th>Credit</th>
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<td>BMI - 301</td>
<td>Biomedical Equipments – II</td>
<td>100</td>
<td>50</td>
<td>7</td>
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<tr>
<td>BMI - 302</td>
<td>Medical Imaging Systems Using Ionizing Radiations</td>
<td>100</td>
<td>50</td>
<td>7</td>
</tr>
<tr>
<td>BMI - 303</td>
<td>Biosensors and Medical Image Processing</td>
<td>100</td>
<td>50</td>
<td>7</td>
</tr>
<tr>
<td>BMI - 304</td>
<td>Microprocessor Based System Design</td>
<td>100</td>
<td>50</td>
<td>7</td>
</tr>
<tr>
<td>BMI - 3P1</td>
<td>Microprocessor Laboratory</td>
<td>100</td>
<td>50</td>
<td>3</td>
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<tr>
<td>BMI - 3P2</td>
<td>Biomedical Instrumentation Laboratory</td>
<td>100</td>
<td>3</td>
<td></td>
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<tr>
<td>BMI - 3P3</td>
<td>Seminar - II</td>
<td>50</td>
<td>1</td>
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<tr>
<td>BMI - 3P4</td>
<td>Hospital/ Industry Training</td>
<td>100</td>
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<td>One Month</td>
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### SEMESTER – IV

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Theory</th>
<th>Practical</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI - 401</td>
<td>Biosignal Processing</td>
<td>100</td>
<td>50</td>
<td>8</td>
</tr>
<tr>
<td>BMI - 402</td>
<td>Medical Informatics</td>
<td>100</td>
<td>50</td>
<td>8</td>
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<tr>
<td>BMI - 403</td>
<td>Automation and Quality Control in Biomedical Engineering</td>
<td>100</td>
<td>50</td>
<td>8</td>
</tr>
<tr>
<td>BMI - 404</td>
<td>Hospital Management Science</td>
<td>100</td>
<td>50</td>
<td>6</td>
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<tr>
<td>BMI - 4P1</td>
<td>Viva-Voce</td>
<td>150</td>
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<tr>
<td>BMI - 4P2</td>
<td>Seminar- III</td>
<td>100</td>
<td>2</td>
<td></td>
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<tr>
<td>BMI - 4P3</td>
<td>Project Work</td>
<td>150</td>
<td>3</td>
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SYLLABUS

SEMESTER –I
BMI - 101  Engineering Mathematics
BMI – 102  Introduction to Anatomy, Physiology and  Biomedical Instrumentation
BMI - 103  Electrical Technology
BMI - 104  Electronic Devices & Circuits
BMI - 105  Communication and Soft Skills Development
BMI - 1P1  Electronic Circuit Laboratory
BMI - 1P2  Computer Applications Laboratory- I
BMI – 1P3  Hospital/Industry Training

SEMESTER –II
BMI - 201  Biomedical Equipments – I
BMI - 202  Digital Electronics and Integrated Circuits
BMI - 203  Object Oriented Programming
BMI - 204  Biophotonics and Non-Radiating Medical Imaging Techniques
BMI - 2P1  Bio-Engineering Laboratory
BMI - 2P2  Computer Laboratory II
BMI - 2P3  Seminar-I
BMI – 2P4  Hospital/Industry Training

SEMESTER –III
BMI - 301  Biomedical Equipments – II
BMI - 302  Medical Imaging Systems Using Ionizing Radiations
BMI - 303  Biosensors and Medical Image Processing
BMI - 304  Microprocessor Based System Design
BMI - 3PI  Microprocessor Laboratory
BMI - 3P2  Medical Electronics Laboratory
BMI - 3P3  Seminar-II
BMI – 3P4  Hospital/Industry Training

SEMESTER –IV
BMI - 401  Biosignal Processing
BMI - 402  Medical Informatics
BMI - 403  Automation and Quality Control in Biomedical Engineering
BMI – 404  Hospital Management Science
BMI - 4P1  Viva-Voce
BMI - 4P2  Seminar-III
BMI - 4P3  Project Work
BMI – 101 ENGINEERING MATHEMATICS

(Sessional Examination: 50 Marks    University Examination: 100 Marks)

This paper enables the student to get an idea about different transformations in the Engineering field and the details of Probability and Statistics. It also includes Linear Programming.

MODULE – I

**Laplace Transforms**: Laplace Transforms, Properties, Inverse Transform, Laplace Transforms of Derivatives and Integrals, Convolution theorem, Transforms of unit step function and unit impulse function, Transforms of periodic function.

MODULE – II

**Fourier Series And Integrals And Special Functions**: Fourier series, Even and odd functions, Half range series, Harmonic analysis, Integral transforms, Fourier Sine and cosine integrals, Beta and Gamma functions and their applications.

MODULE – III

**Fourier Transform**: Infinite Fourier transform, Properties, Finite Fourier transform, Sine and cosine transform, Convolution theorem, Parseval's identity.

MODULE – IV


MODULE – V

**Linear Programming**: Mathematical Formulation of LPP graphical solution, Simplex method, Duality concept.

Transportation problem, Assignment problem, Mathematical Formulation, Unbalanced Assignment problem.
Reference:


University Examination Question pattern:

12 questions of 10 marks from module I to module V with choice to answer any ten.
BMI – 102 INTRODUCTION TO ANATOMY, PHYSIOLOGY AND BIOMEDICAL INSTRUMENTATION

Part A (Introduction to Anatomy) and Part B (Introduction to Physiology) are able to give general awareness of overall structure and function of systems (detailed study not required). The objective of the subject is to understand the different parts of the body in relation with various Biomedical Equipments.

PART-A INTRODUCTION TO ANATOMY

30 Hours

Structure of heart, Structure of lungs ,Structure of Cerebrum, Cerebellum, Hypothalamus.
Structure of Stomach, Small Intestine, Large Intestine, liver, Structure of kidney, Urinary bladder, Structure of Pancreas, thyroid and parathyroid glands, Structure of ovary and testis.

PART-B INTRODUCTION TO PHYSIOLOGY

30 Hours

Respiratory System: Transport of gases, Regulation of breathing, hypoxia.

Digestive system: Functions of stomach, pancreas, liver. Composition of digestive fluids, peristaltic movement.

Circulatory system: Blood, composition and functions of blood cells (RBC, WBC and platelets). Function of heart – capillary and coronary circulation, Hormonal and long term regulation of BP.

Nervous system: Functions of Cerebrum, Cerebellum and Hypothalamus, Functions of Autonomous Nervous System (Sympathetic & Parasympathetic).

Excretory system: Physiology of urine formation,

Reproductive system: Function of ovary and testis.

Endocrine system: Hormone synthesis and functions.

PART-C INTRODUCTION TO BIOMEDICAL INSTRUMENTATION

60 Hours

This paper will enable the students to learn the basic principles of the physiological signals. Also, it gives an overview of basic measuring instruments and amplifiers used in medical field.

MODULE – I

Bioelectricity: Excitable cells, Nernst potential, Resting membrane potential, Polarized state, Action potential, de-polarization, re-polarization, Propagation of nerve impulses, Refractory period – absolute and relative, Modes of transport of substances across the cell membranes.
MODULE – II

Electrocardiogram: Electrical activity of the heart – Cardiac muscle, Action potentials in cardiac muscle, SA node, Origin and propagation of rhythmical excitation & contraction, regular and ectopic pacemakers, ECG waveforms and their significance, Arrhythmias – abnormal rhythms, heart blocks, premature contractions, flutter, fibrillation, vulnerable period.


Electromyogram: Electrical activity of muscles – neuromuscular junction, synaptic potentials, artifacts, motor unit action potentials – nerve conduction studies – NCV.

MODULE – III

Electrodes for measurement of biopotentials: Electrode-tissue interfaces, electrode-electrolyte and electrolyte-skin interfaces, Skin contact impedance, Electrodes for ECG, EEG, EMG.

Basic measuring instruments: Multimeters – analog and digital multimeters. Frequency and time measurement – analog CRO and digital storage oscilloscope. Medical display systems – single and multichannel displays, nonfade displays, LED and LCD displays.

Writing systems: Different types of recorders.

Preamplification: Difference amplifiers, Chopper amplifiers, Carrier amplifiers, Instrumentation amplifiers, Isolation amplifiers.

Reference:


University Examination Question pattern:

<table>
<thead>
<tr>
<th>Part A (Anatomy)</th>
<th>6 questions of 5 marks with choice to answer any five.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part B (Physiology)</td>
<td>6 questions of 5 marks with choice to answer any five.</td>
</tr>
<tr>
<td>Part C (Introduction to Biomedical instrumentation)</td>
<td>I - 4 questions of 10 marks from module I to module III with choice to answer any three.</td>
</tr>
<tr>
<td></td>
<td>II - 5 questions of 5 marks from module I to module III with choice to answer any four.</td>
</tr>
</tbody>
</table>
BMI – 103 ELECTRICAL TECHNOLOGY

(Sessional Examination: 50 Marks  University Examination: 100 Marks)

The objective of this paper is to understand the electrical circuits and theorems in the Biomedical field. Also, it enables the students to get an idea about the basic electrical equipments.

MODULE – I

DC Circuits: Kirchoff’s Laws, Node and Mesh analysis, Voltage and Current source transformations, Star and Delta transformations, Superposition, Thevenin, Norton, Maximum power transfer, Tellegan, reciprocity and Compensation theorems.

MODULE – II

AC Circuits: Series and parallel AC circuit, RL – RC and RLC circuits, phasor diagram, Active power, Reactive power and apparent power, Series and parallel resonance circuits, Bandwidth and selectivity of resonant circuits.

Coupled circuits and coefficient of coupling, Self and Mutual Inductances.

MODULE – III

Three Phase Circuits: Three Phase Circuits, Balanced circuits, Star and Delta connected loads, Unbalanced circuits, Solution of Unbalanced Star and Delta connected loads, Power measurements by two Watt meters method.

Transformers: Transformer theory, current and voltage relations in primary and secondary windings, e. m. f. equations, Vector diagrams, Losses and efficiency, Open circuit and short circuit tests, Regulations – 3 Phase transformers – Auto transformers.

MODULE – IV

DC Machines: DC Generators – Shunt, Series and compound generators, EMF equation, Losses and efficiency, Commutation, Armature reactions, Characteristic curves, DC Motors, Back emf, Torque equation, Losses and efficiency; Characteristic curves, shunt, series and compound Motors, speed control of DC motors and Starters.

MODULE – V

AC Machines: Ac Generators, Rotor and stator windings, emf equations, Frequency, Synchronous speed, Losses and efficiency.

Synchronous motors, Vector diagram for varying excitations, V Curves.

**MODULE – VI**

**Special Machines and Measuring Instruments**: Tacho generators, AC and DC servo motor, stepper motor, Linear Induction Motor, Relays and Contractors, Circuit Breakers – MCBs and ELCBs, Current and Potential Transformers, Protective systems – Fuses – Isolators and switches, Earthing, Surge protectors.


**Reference:**

2. “*Industrial Instrumentation*”, W.Prabhakararao.
4. “*Electrical Technology*”, Edward Hughes, Addison Wesley Publication.

**University Examination Question pattern:**

<table>
<thead>
<tr>
<th>Part A</th>
<th>6 questions of 10 marks from module I to module VI with choice to answer any five.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part B</td>
<td>12 questions of 5 marks from module I to module VI with choice to answer any ten.</td>
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</tbody>
</table>
BMI -104 ELECTRONIC DEVICES & CIRCUITS

(Sessional Examination: 50 Marks  University Examination: 100 Marks)

This paper introduces an idea about basic electronic devices which include passive and active devices. It also helps to understand the basic electronic circuits such as wave shaping circuits, wave generating circuits, etc…

MODULE -I


Special Diodes: Principles and operation – Tunnel, PIN, Varactor, Photodiodes, LED, LVD, LDR and Thermistor. Thyristors – Classification & Constructional Details.


MODULE –II

Amplifier circuits: Biasing techniques of BJT, stabilization of operating point, concept of load lines, Analysis and design of BJT amplifier circuits in common emitter, common collector and common base configurations, Frequency response of RC coupled amplifier. FET and MOSFET amplifiers, Multistage amplifiers (RC coupled and Transformer coupled).

Negative feedback: Effect of negative feedback on amplifier performance, Voltage series, current series, Voltage shunt, feedback arrangements, design of feedback amplifiers, Darlington connection.

MODULE –III


MODULE – IV


Multivibrators – Astable, Monostable and Bistable circuits using BJTs – Applications.

Reference:


University Examination Question pattern:

Part A - 6 questions of 10 marks from module I to module IV with choice to answer any five.
Part B - 12 questions of 5 marks from module I to module IV with choice to answer any ten.
Module I  Communication
Communication in management process – effectiveness – Communication opportunities –
Group communication – Methods – Problems – Solutions – Meetings
Speeches – Structure of speech – Drafting of speech – Speeches for different occasions,
Interview – Listening and observation skills – Body language.

Module II  Reports
Business correspondence – Drafting of letters – Circulars – Answering letters.
Meeting documentation – Notice of the meeting – Agenda – Chairman’s speech – Recording meetings – Writing minutes – Minute book – Writing meeting reports – Assignment – Writing annual report

Module III  Group Process lab:
Planning, preparation, delivery, feedback and assessment of – public speaking, group discussion and oral presentations.

Module IV  Time Management
Team Building, Stress Management, Setting skills.

Module V  Career Skills
Curriculum Vitae and Cover Letters, Facing an interview, Presentation Skills, Persuasion Skills.

Module VI  Communication Lab Activities.
Reference:
1. Dalmer Fisher: Communication in Organization’s, Jaico Publishing Co., Bombay
3. Rajendra Pai & Bhatnagar OP: Education and Communication for department
1. Familiarization of Electronic Components and Electrical Equipments.
2. Electric wiring, soldering, etc.
3. PCB Fabrication.
   i) Forward characteristics of a Diode
   ii) Forward and reverse characteristics of a Zener Diode
   iii) Characteristics of a Transistor
   iv) Characteristics of an FET
5. Clipping and Clamping circuits using Diodes.
6. Differentiating circuit and Integrating circuits.
7. Rectifying circuits.
   i) Half Wave Rectifier
   ii) Full Wave Rectifier
   iii) Full Wave Bridge Rectifier
   iv) Filter circuits - Capacitor filter, Inductor filter, LC filter and Pi section filter (Measurement of ripple factor)
8. Biasing of BJT.
10. Oscillators and Multivibrators.

**BMI- 1P2 COMPUTER APPLICATIONS LABORATORY**
( Sessional Examination: 50 Marks  University Examination: 100 Marks)

1. Computer fundamentals, Computer Organization, etc…
2. MS OFFICE
3. Programming in C.

**Reference:**
BMI- 1P3 HOSPITAL/INDUSTRY TRAINING

(Sessional Examination: 50 Marks)

The students should get ten days in-plant training in a Hospital/Industry. The aim of the training is that the students get familiarized with the various Medical Equipment and the topics included in the syllabus. The students shall submit a report based on this training and make a presentation of it.
BMI 201 BIOMEDICAL EQUIPMENTS– I

(Sessional Examination: 50 Marks    University Examination: 100 Marks)

This subject is to provide an overview of different Biomedical instruments and their classification. It emphasis the principles and operation of analytical and diagnostic instruments.

MODULE-I
Overview of Biomedical Instrumentation system – Types of biomedical equipments – Analytical, Diagnostic, Therapeutic and Surgical equipments – calibration of medical devices and testing of biomedical equipments.

MODULE – II
Hb meter, Blood cell counters, Auto analyzers, Radio Immuno Assay and ELISA techniques.
Mass spectroscopy, flow cytometry – Principles and applications. Electrophoresis – Principles and applications.

MODULE – III
Principles and applications –Vector cardiography (VCG), Magnetocardiography (MCG) – SQUIDS and Phonocardiography (PCG).
Cardiac stress testing – bicycle and treadmill tests – protocols. Cardiac output measurement – different techniques.
Principles and applications – Magneto encephalography (MEG), Electroretinography (ERG) and Electrooculography (EOG).
Principles and applications – Electromyography (EMG) – Electroneurography (ENG).

Principles of thermography, Detecting circuits, its application in medicine.
MODULE – IV

MODULE – V
Audiometers – Pure tone, Speech and Mask audiometers, Bekesy audiometers, Tympanometers. Hearing aids, Cochlear implants, Ear moulds.
Densitometers – Principle and applications.

Reference:

University Examination Question pattern:
Part A - 6 questions of 10 marks from module I to module V with choice to answer any five.
Part B - 12 questions of 5 marks from module I to module V with choice to answer any ten.
The aim of the paper is to learn the basic digital circuits and their uses. This paper also enables the student to understand the circuits using op-amps which have wide applications in the field of medicine.

MODULE -I

Number System and Codes: Binary, Octal, and Hexa-decimal number systems, Binary coded Decimal, Excess - 3 code, Gray Code. Binary arithmetic and Complement of numbers, Addition and subtraction with BCD.

Boolean algebra – De-Morgan’s Theorem. Minimization of Boolean function using Boolean Theorems, Karnaugh Map and Quine – McClusky methods. Realization of logic function using NAND, NOR.

Combinational Circuits: Multiplexer, Demultiplexer, Decoder, Decoder.

Arithmetic Circuits: Half adder, Full adder, Serial and parallel addition – Carry look ahead adder, Subtractor.

MODULE –II


Logic Families: DCTL, RTL, DTL, TTL, ECL, CMOS, Tri-state logic – specification and transfer characteristics of basic TTL – Current and voltage parameters – Fan in and Fan out – Propagation delay, noise consideration, Comparison.

MODULE –III


Inverting and non-inverting amplifier, summer, subtractor, average, Integrator and differentiator, instrumentation amplifier, voltage to current and current voltage convertor, voltage to frequency convertor, clipper, clamper, Log and Antilog amplifiers. Sample and hold circuit, Precision rectifiers.

MODULE – IV

Comparator: Applications of comparator, Zero crossing detector, Regenerative comparators (Schmitt trigger).


Wave generators: Triangular and saw tooth, RC phase shift and Wien bridge oscillators. ADC – successive approximation, flash, integrating. DAC – weighted, R-2R.

MODULE – V

Active Filters: Transfer functions – LPF, HPF, BPF, and BRF. Approximation methods – Butter worth – Chebyshev Filters – I order and II order filters – All Pass filters – Quality factor.


Reference:


University Examination Question pattern:

| Part A | 6 questions of 10 marks from module I to module V with choice to answer any five. |
| Part B | 12 questions of 5 marks from module I to module V with choice to answer any ten. |
This paper is designed to understand the basic object oriented programming languages. It emphasis C++ programming language with programming examples.

MODULE-I

Object oriented programming principles, Definition and motivation of object oriented programming languages, Features of object oriented programming languages- data abstraction, encapsulation, classes and objects, genericity, inheritance, polymorphism and dynamic binding, garbage collection, exception handling.

MODULE –II

The C++ programming language – History, data types, expression, statements, operators. The class- member variables and functions, scope of class members- program level, file level and local. Objects and initialization, pointer to class members, class argument and ellipsis. Functions- function prototypes and strong type checking, argument passing, returning a value, constructors and destructors, pointers to functions.

MODULE –III


MODULE- IV

Miscellaneous features – Union, bit field, type safe linkage, C++ Vs C, programs in C++. 
Reference:
7. The C++ Programming Language, Pearson (2008), Bjarne Stroustrup

University Examination Question pattern:

<table>
<thead>
<tr>
<th>Part A</th>
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<td>Part B</td>
<td>12 questions of 5 marks from module I to module IV with choice to answer any ten.</td>
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</table>
The objective of this paper is to understand the uses of laser in medical field and holographic imaging techniques. Also, it helps to learn the principles and applications of ultrasound. The principles and applications of MRI are also included in this paper.

MODULE –I


MODULE –II

Holography: Introduction, Recording and Reconstruction of holograms, Holographic Recording media, Holographic memory, Holographic Interferometry, Motion induced contrast images, Holographic computer, Holographic application in medicine, Correlation filtering, Fourier optics.

MODULE –III

Medical ultrasound: Physics of ultrasonic waves, Interactions with body matter, Generation and detection, Single element transducer construction, Linear and sector scanning Transducer arrays, Different modes of display, Modes of transmission of ultrasound, Colour Doppler, Ultrasonic diagnosis in Abdomen, Breast, Heart, Chest, Eye, Kidney, Skull, Pulsatile motion, Pregnant and Non-Pregnant uterus.

Ultrasound pulse echo imaging system, Design of scan converters, Design of frame grabbers, 2D scanners.

MODULE –IV

Reference:


University Examination Question pattern:

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</table>
**BMI- 2P1 DIGITAL AND ANALOG CIRCUITS LABORATORY**

*(Sessional Examination: 50 Marks  University Examination: 100 Marks)*

1. Study of Logic circuits – AND, OR, NOT, NAND, EX-OR, etc.
2. Design of half adder and full adder using NAND and NOR gates.
3. Design of half subtractor and full subtractor using NAND and NOR gates.
5. Sequential Logic circuits, Counters, Registers etc.,
6. Study of IC counters.
7. Study of op amps and basic circuits using op amp.
   (Comparator circuits, arithmetic circuits, simple amplifier circuits)
8. First order and second order high pass and low pass filters.
9. Precision rectifiers (Half wave and Full wave).
13. Phase detector  14. Sample and Hold circuit

**BMI- 2P2 COMPUTER LABORATORY-II**

*(Sessional Examination: 50 Marks  University Examination: 100 Marks)*

1. Programs in C++.

**BMI- 2P3 SEMINAR-I**

*Sessional Examination: 50 Marks*

The Seminar to be presented shall include any topic of current areas of Bio-Medical Instrumentation coupled with clinical practice. The Seminar shall be carried out under the supervision of Faculty Member in the Department. Students shall individually prepare and submit a seminar report. Each student shall present a seminar for about 15 minutes duration on the selected topic. The report and presentation shall be evaluated based on style of presentation, technical content, adequacy of references, depth of knowledge and overall quality of the seminar report.

**BMI- 2P4 HOSPITAL/INDUSTRY TRAINING**

*Sessional Examination: 50 Marks*

The students should get fifteen days in-plant training in a hospital/industry. The aim of the training is that the students get familiarized with the various Medical Equipments and the topics included in the syllabus. The students shall submit a report based on this training and make a presentation of it.
BMI 301 BIOMEDICAL EQUIPMENTS– II

(Sessional Examination: 50 Marks   University Examination: 100 Marks)

This paper will enable the students to learn the principle and operation of Therapeutic and Surgical instruments. Also, it gives an idea of Hospital gas supply system and details about electrical safety. Recent advances in Biomedical field also summarizes in this paper.

MODULE-I

Cardiac pacemakers: Classification – External and internal (implantable) pacemakers, Synchronous and asynchronous pacemakers, programmable pacemakers, power sources, Pacing system analyzers.

Cardiac defibrillators: Classification – AC and DC defibrillators, Biphasic and Monophasic, Basic principles and comparison of output waveforms of different DC defibrillators, Energy requirements, Synchronous, manual and asynchronous operation, implantable defibrillators, defibrillator analyzers, AED.

MODULE –II


MODULE –III

Physiotherapy Equipments: Diathermy – Microwave diathermy, Shortwave diathermy, Ultrasonic diathermy, Ultrasonic stimulators, Electrotherapy, TENS, IFT, Ultrasonic nebuliser.

Cryogenics: Principles of cryogenic techniques, Application of cryogenics in medical field.

MODULE –IV

Operation theater equipments: Surgical Light, Operating Table, C Arm, Craniotomy, Electrosurgical Machines (ESU), Electrosurgical analyzers, Surgical aspirator, Anesthesia machine, Anesthesia gas monitor, Surgical microscope.
MODULE –V

Hospital Gas supply system: Centralized supply of air, Oxygen, Nitrogen, Nitrous oxide, CO₂, Vacuum, Principle and Production of liquid Oxygen.


PACS, DICOM, Introduction to Nanotechnology.

Reference :
8. “Nanotechnology: A Gentle Introduction to the Next Big Idea”, Mark A Ratner, Daniel Ratner, PHI.

University Examination Question pattern:

| Part A | - 6 questions of 10 marks from module I to module V with choice to answer any five. |
| Part B | - 12 questions of 5 marks from module I to module V with choice to answer any ten. |
The objective of this paper is to understand the underlying physics of the medical imaging systems and to give an overview of major modern diagnostic imaging technologies. Also, it supports more in depth investigations into radiography and nuclear medicine imaging modalities.

MODULE –I

X-rays: Principle and production of X-rays, Interaction of X-rays with matters, Transfer characteristics of screen, Film and image intensifier systems, Properties of X-ray films and screens, Characteristics of Imaging system by image modulation transfer functions, Characteristics of high fidelity television chains.


MODULE –II


Module –III

CT principles – Principles of sectional imaging, generations – CT image formation, conversion of X-ray data into scan image – mathematical details of various algorithms– Principles of 3D imaging. Types of CT scanners – spiral CT, multi slice CT.

Radiation safety – safety precautions – Hazardous effects of radiation– Allowed level protection methods.
MODULE – IV


Reference:

University Examination Question pattern:

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</table>
This paper introduces an idea about various biological sensors present in human body. It also provides an overview of different transducers and biosensors in Medical field and also introduces the applications of BioMEMs. This paper also helps to understand the techniques of image processing.

MODULE – I

Study of biological sensors in human: Classification of various receptors – Mechanical receptors – touch, pressure and pain receptors, tactile receptors, taste receptors, sensors for smell, receptors of sound – Mechanism of hearing, receptors of vision – Mechanism of sight – Functions of rods and cones. Baro receptors in aorta – J receptor in the lungs – Osmolality.

MODULE – II


MODULE – III

Biosensors: Ion sensors – Anion and cation sensors, Membrane electrodes, Enzyme electrodes – Biocatalyst based biosensors – ISFET for glucose, urea etc. Fibre optic sensors, Photo voltaic transducers, Photo acoustic sensors and Radiation thermometry.

Data acquisition and recording: Signal conditioners, Single and multichannel data acquisition systems, Data transmission systems, Multicolour dot scanner.

MODULE – IV

Introduction to Microsystems: MEMS and BioMEMs, MEMS materials, MEMS Devices, Applications in medical field – BioMEMs as a biosensor, BioMEMs for Diagnosis, BioMEMs in Medical implants and surgery.
MODULE – V


**Reference:**

2. “*Essentials of Medical Physiology*”, Mahapathra.

**University Examination Question pattern:**

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</table>
BMI 304 MICROPROCESSOR BASED SYSTEM DESIGN

( Sessional Examination: 50 Marks University Examination: 100 Marks)

This subject is to provide an overview of microcomputers, microprocessors and memories. It includes the introduction and architecture of 8-bit and 16-bit microprocessors. It also includes the assembly language programming with 8085 microprocessor.

MODULE –I


MODULE –II

Assembly Language Programming: 8085 instruction set: Instructions, Classifications, Addressing modes, Stack and Subroutines, Delay routines, Counters etc. Programming examples.

Instruction Timing and Interrupts: Timing Diagrams (of various instructions): T-state, Machine cycle (Opcode fetch, Read / Write, Interrupt Acknowledge, etc), Interrupts: - types, Maskable / Non maskable, their organization.

Memories: Memory design: Semiconductor memories, RAM, ROM, EPROM, Programmable logic array, charge coupled devices content accessible memories, Magnetic cone/ drum/ disc memories, Magnetic bubble memories. Static and dynamic RAM devices, Concepts of popular memory chips, Design of typical memory capacity using standard chips, address decoding I/O addressing schemes, CD, ROM.

MODULE –III

Memory interface: Concept of memory chip/ chips interface to 8085 with appropriate examples.

Programmable interfacing devices: Programmable peripheral interface (Intel 8255), Programmable timer interface (Intel 8253/ 54), Programmable display / Keyboard interface (Intel 8279), Programmable serial communication interface (Intel 8251) – their inter face to 8085, DMA controllers.
MODULE –IV

Introduction to 16 bit microprocessors: Architecture of 8086, Addressing modes, Modular programming – definition, 8086/8088 multiprocessing system, 8087 numeric data processor, 8089 I/O processor, Architecture of MC 68000.

MODULE –V


Reference:


University Examination Question pattern:

| Part A | 6 questions of 10 marks from module I to module V with choice to answer any five. |
| Part B | 12 questions of 5 marks from module I to module V with choice to answer any ten. |
BMI- 3P1 MICROPROCESSOR LABORATORY
(Sessional Examination: 50 Marks  University Examination: 100 Marks)

1. Study of a typical microprocessor trainer kit and its operation.
2. Simple programming examples using 8085 instruction set to understand the use of various instructions and addressing modes.
   (a) Complement a number.
   (b) Addition of binary and BCD numbers.
   (c) Subtraction of binary and BCD numbers.
   (d) Fibonacci series.
   (e) Largest and smallest of numbers.
   (f) Arrange numbers in ascending and descending order.
   (g) Sum of series of numbers.
   (h) Parity checking.
   (i) String concatenation.
   (j) String comparison.
   (k) Elimination of numbers from a string.

BMI – 3P2 BIOMEDICAL INSTRUMENTATION LABORATORY
(Sessional Examination: 100 Marks)

1. ESU waveform generator
2. Power amplifier for stylus movement
3. Design of pacemaker circuits
4. Study of medical equipments
   1. ECG  2. PCG
   3. EEG  4. EMG
   5. Monitor  6. Sphygmomanometer
   7. Analytical equipments such as colorimeter, PH meter, Hb meter
   8. Fetal monitor  9. Spirometer
   10. Plethysmograph  11. Defibrillator
   12. Oxygenator  13. Infusion pump
BMI -3P3 SEMINAR-II

Sessional Examination: 50 Marks

The Seminar to be presented shall include any topic of current areas of Bio-Medical Instrumentation coupled with clinical practice. The Seminar shall be carried out under the supervision of Faculty Member in the Department. Students shall individually prepare and submit a seminar report. Each student shall present a seminar for about 15 minutes duration on the selected topic. The report and presentation shall be evaluated based on style of presentation, technical content, adequacy of references, depth of knowledge and overall quality of the seminar report.

BMI- 3P4 HOSPITAL/ INDUSTRY TRAINING

Sessional Examination: 100 Marks

The students should get one month in-plant training in a hospital/industry. The course of training is intended to serve the candidate to acquire sufficient knowledge, skills and exposure to various Medical Equipment / Instruments in the field of operation, calibration, servicing, maintenance, periodical checkup and Installation etc., of Health care equipments used in Hospitals/ Industries. Also cover all aspects of job role performed by Bio- medical engineers.
This paper introduces fundamental concepts of signal processing. It gives an overview of various Biological signals and applications of signal processing in them.

MODULE –I


MODULE –II


MODULE –III


MODULE –IV


Application in Biological Signals: These techniques applied in processing of various signals like ECG, EEG, PCG, Evoked potentials.
Reference:


University Examination Question pattern:

12 questions of 10 marks from module I to module IV with choice to answer any ten.
MODULE I - MEDICAL INFORMATICS
Introduction - Structure of Medical Informatics –Internet and Medicine -Security issues, Computer based medical information retrieval, Hospital management and information System, Functional capabilities of a computerized HIS, E-health services, Health Informatics – Medical Informatics, Bioinformatics.

MODULE II - COMPUTERISED PATIENT RECORD
Introduction - History taking by computer, Dialogue with the computer, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, computerized prescriptions for patients.

MODULE III - COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING
Automated clinical laboratories-Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computerized ECG, EEG and EMG, Computer assisted medical imaging- nuclear medicine, ultrasound imaging Ultrasonography-computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance

MODULE IV - COMPUTER ASSISTED MEDICAL DECISION-MAKING
Neuro computers and Artificial Neural Networks application, Expert system – General model of CMD, Computer – assisted decision support system-production rule system cognitive model, semester networks , decisions analysis in clinical medicine-computers in the care of critically patients-computer assisted surgery-designing

MODULE V - RECENT TRENDS IN MEDICAL INFORMATICS
Virtual reality applications in medicine, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery computer aids for the handicapped, computer assisted Instrumentation in Medical Informatics - Computer assisted patient education and health - Medical education and health care information.

MODULE VI - DATABASES AND COMPUTER NETWORK
Reference:

University examination question pattern:
Part A - 6 questions of 10 marks from module I to module VI with choice to answer any five.
Part B - 12 questions of 5 marks from module I to module VI with choice to answer any ten.
BMI 403 AUTOMATION AND QUALITY CONTROL IN BIOMEDICAL ENGINEERING

( Sessional Examination: 50 Marks    University Examination: 100 Marks)

This paper is designed to understand the concept of automation and apply the same in the field of medicine. It lays emphasis on specialized robotic systems and critical surgeries performed by them. Also, it attempts to make better understanding of Quality standards and management methodologies in Biomedical Engineering.

MODULE –I


MODULE –II


Robotic systems: Robotic Radio surgery system, Computer assisted surgery and Rehabilitation Robotics in Virtual environment.

MODULE –III

Biomedical Applications of Medical Robotics: Nerve cell repair using Micromechatronics, Micro and Nanodevices for targeted delivery of medicines to tumour sites and diagnosis using navigable biosensors, Surgeries performed using robotic systems – Mitral valve Surgery and minimally invasive surgeries, Surgical procedures in General surgery, Neurology, Urology, Gastroenterology, Cardiology, Orthopedics, Pediatrics and Radio surgery.

MODULE –IV

Quality Control: Quality control tools, Problem solving methodologies, New Management Tools, Quality policy development, Quality function development, Designing for Quality, Manufacturing for Quality.
MODULE – V

**Need for Standardization:** Regional, National, International Standardization, Methods for Testing Standardization, Maintenance of Standardization & Recalibration, Food and Drug Administration Regulations.

**Reference:**


**University examination question pattern:**

Part A - 6 questions of 10 marks from module I to module V with choice to answer any five.

Part B - 12 questions of 5 marks from module I to module V with choice to answer any ten.
This paper provides an overview of planning, purchasing and maintenance of Hospital equipments. It also supports to understand hospital management and accreditation of hospitals.

MODULE – I  Hospital Organisation and Management
Hospital as an Organisation – Types of hospitals – Introduction to Clinical, Supportive, and Ancillary Services. Planning of Bio-Medical Department.

MODULE – II  General Management

MODULE – III  Personnel Management

MODULE – IV  Purchase Management

MODULE – V  Marketing Management

MODULE – VI  Total Quality Management
Reference
5. S.K.Joshi-Quality Management in Hospitals Jaypee Brothers.

University examination question pattern:
PART A - 6 questions of 20 marks from module I to module VI with choice to answer any four.
PART B - 6 questions of 5 marks from module I to module VI with choice to answer any four.
BMI 4P1 VIVA – VOCE

University Examination: 150 Marks

A comprehensive Viva-Voce examination related with all subjects covered in the scheme of study will be conducted by the University. The students shall produce the Hospital Training Reports, Seminar Reports and Project Report duly attested by the institutional authorities, before the examiners. The examiners shall evaluate the students in terms of their conceptual grasp of the course of study and practical/analysis skills in the Bio-Medical Engineering field.

BMI 4P2 SEMINAR-III

Sessional Examination: 100 Marks

The Seminar to be presented shall include any topic of current areas of research within Bio-Medical Engineering coupled with clinical practice. The Seminar shall be carried out under the supervision of Faculty Member in the Biomedical Instrumentation Department concerned. Students shall individually prepare and submit a seminar report. Each student shall present a seminar for about 30 minutes duration on the selected topic. The report and presentation shall be evaluated based on style of presentation, technical content, adequacy of references, depth of knowledge and overall quality of the seminar report.
BMI 4P3 PROJECT WORK

Sessional Examination: 150 Marks

The Project work shall be carried out in an aesthetic dimension and innovation of creative ideas to be useful in Bio-Medical field. It shall be carried out in a hospital or in a company, individually. It should include a detailed study of any equipment or the equipments and facilities of any area in the hospital. The Project work shall be carried out under the supervision of Faculty Member in the Biomedical Instrumentation Department concerned. A detailed report on the work done shall be submitted by each student. The evaluation of the Project shall include Presentation of the work, Oral examination and Quality and Content of the project report.

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