

Government of Karnataka
Department of Technical Education
Board of Technical Examinations, Bengaluru

Course Title : Medical Electronics	Course Code : 15EC63A
Semester : 6	Course Group : Elective
Teaching Scheme in Hrs (L:T:P) : 4:0:0	Credits : 4
Type of course : Lecture + Assignments	Total Contact Hours : 52
CIE : 25 Marks	SEE : 100 Marks

Prerequisites

Knowledge of analog and digital circuits, measurement systems and transducers.

Course Objectives

1. Discussion of the issues involved in man-instrument interface
2. Understand the working principles of various therapeutic and monitoring systems
3. Discuss general principles of imaging systems
4. Familiarization of the techniques of biotelemetry and the standard practices of achieving patient safety

Course Outcomes

On successful completion of the course, the students will be able to attain the following COs

Course Outcome		CL	Linked PO	Teaching Hrs
CO1	Comprehension of the nature and origin of bio-signals from parts of human body and the relevant transducers required to detect such signals	R/U/A	1,2,6,7,10	8
CO2	Understand recording and analysis of prominent bio-signals of human	R/U/A	1,2,6,7	8
CO3	Familiarization with human assist devices	R/U/A	1,2,6,7,8	10
CO4	Understand the measurement and analysis techniques for physiological parameters	R/U/A	1,2,4,10	10
CO5	Understand the patient imaging and monitoring systems	U/A	1,2,5,6,9	9
CO6	Understand Biotelemetry, telemedicine, patient safety and E-waste management.	U/A	1,2,4,5,6,7,9,10	7
			Total	52

Legends: PO-Program Outcome, CO-Course Outcome, CL-Cognitive Level, R-Remember, U-Understand, A-Apply

Mapping Course Outcomes with Program Outcomes

Course Outcomes	Programme Outcomes									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	*	*	--	--	--	*	*	--	--	*
CO2	*	*	--	--	--	*	*	--	--	--
CO3	*	*	--	--	--	*	*	*	--	--
CO4	*	*	--	*	--	--	--	--	--	*
CO5	*	*	--	--	*	*	--	--	*	--
CO6	*	*	--	*	*	*	*	--	*	*

Legend
 : *
 Linked,
 -- No
 link

Course-PO attainment matrix

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
Medical Electronics	3	3	0	2	3	3	2	0	3	2

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Low Addressed.
 Method is to relate the level of PO with the number of hours devoted to the COs which address the given PO.
 If $\geq 40\%$ of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 3
 If 25 to 40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 2
 If 5 to 25% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 1
 If $< 5\%$ of classroom sessions addressing a particular PO, it is considered that PO is considered not-addressed.

Course content and pattern of marks for SEE

Unit No	Unit Name	Hour	Questions to be set For SEE			Marks	Weightage (%)
			R	U	A		
1	Bioelectric signals	8	5	5	10	20	14
2	Bio potential Recorders	8	5	10	10	25	17
3	Therapeutic Equipment	10	10	10	10	30	21
4	Measurement and analysis techniques	10	10	10	10	30	21
5	Imaging systems	9	5	10	10	25	17

6	Biotelemetry and patient safety	7	5	5	5	15	10
	Total	52	40	50	55	145	100%

Legend: R- Remember, U-Understand A-Application

Course Contents

Unit - 1: Bioelectric signals 08 Hours

Cell characteristics. **Bio-electric potential:** Origin, Resting and action potential, depolarization and repolarisation, propagation of action potentials, ECG, EEG and EMG waveforms with typical characteristics. **Electrodes:** Types, Electrodes used for ECG, EEG and EMG. Selection of physiological transducers.

Unit - 2: Bio potential Recorders 08 Hours

Basic recording systems. Block diagram of ECG, isolated preamplifier, ECG leads, effects of artifacts on ECG recordings, Multichannel ECG machine, Block diagram of EEG machine, 10-20 electrode placement system for EEG, and Evoked potential. Working of EMG with block diagram. Applications of ECG, EEG, EMG and ERG recordings.

Unit – 3: Therapeutic Equipment 10 Hours

Cardiac pacemakers- external and implantable pacemakers and programmable pacemaker. Defibrillator-internal and external, AC and DC defibrillators, block diagram of microprocessor-based defibrillator. Dialysis- working of a haemodialyser. Working of digital hearing aid. Diathermy- types, schematic of microwave diathermy unit, Surgical diathermy – principle , working of solid state surgical diathermy machine. Laser- different types of lasers and their applications in medicine, argon **laser- block diagram of gastric photocoagulator**. Electrotherapy – types of waveforms used, electrotherapeutic muscle stimulator.

Unit - 4: Measurement and analysis Techniques 10 Hours

Blood constituents- calculation of size of cells- MCV, MCH, MCHC, MPV, RDW & PDW, Blood cell counter- Coulter's method and Dark field method, Digital pH meter, Spectrophotometer, **Oximetry - finger tip oximeter**. Features of Blood flow meters. Ultrasonic Doppler-shift based FHR measurement. BP measurement-systolic & diastolic pressure, direct method and indirect methods, **Bp measurement using ultrasonic doppler shift method, advantages & disadvantages. Rheographic method of indirect blood flow measurement.**

Unit -5: Imaging systems 09 Hours

X-Rays- properties, X-ray imaging machine, applications, advantages and disadvantages. Computerized tomography- basic principle, block diagram of a typical CT imaging system, advantages, disadvantages and applications of CT imaging. Magnetic resonance imaging- principles of NMR imaging, basic components of a typical NMR imaging system, applications, advantages and disadvantages of magnetic resonance imaging. Ultra sonic imaging-properties of ultrasonic waves, basic pulse echo apparatus. Concept and features of patient monitoring system.

Unit- 6: Biotelemetry and Patient safety 07 Hours

Biotelemetry- Introduction, components of Biotelemetry a system, Single channel bio telemetry system, Applications of biotelemetry. **Telemedicine**-concept, essential parameters, telemedicine using mobile communication. **Patient safety**-Physiological effects of electric current, micro and macro shock- preventive measures, safety standards, effects of radiation exposure, SAR as applicable to mobile phones. **E-waste**- Sources and disposal.

References

1. *Hand book of Bio Medical Instrumentation*(2nd edition)- R.S. Khandpur, ISBN-13: 9789339205430
2. *Introduction to Biomedical Instrumentation* –Mandeep Singh. ISBN-13: 9788120350236
3. *Principles of Medical Electronics and biomedical Instrumentation*- S.K. Guha ISBN-13: 978-8173712579
4. *Medical instrumentation Application and design*J.G.Webster(Wiley India) ISBN-13: 978-0471676003
5. *Biomedical Instrumentation* –Dr.M. Arumugam ISBN 13: 9788187721123.

Course Delivery

The course will be delivered through lectures, presentations and support of modern tools.

Course Assessment and Evaluation Scheme

Master Scheme

Assessment Method	What		To Whom	Assessment mode /Frequency /timing	Max. Marks	Evidence Collected	Course Outcomes
Direct assessment	CIE	IA	Students	Three tests ⁺	20	Blue Books	1 to 6
				Activity*	05	Activity Sheets	1 to 6
	SEE	End exam		End of the course	100	Answer Scripts at BTE	1 to 6
				Total	125		
Indirect assessment	Student feedback on course		Students	Middle of the Course	Nil	Feedback Forms	1 to 3 Delivery of course
	End of course survey			End of the Course	Nil	Questionnaires	1 to 6 Effectiveness of delivery instructions & assessment methods

Legends: CIE-Continuous Internal Evaluation, SEE- Semester End-exam Evaluation

⁺ Every I.A. test shall be conducted for 20 marks. Average of three tests, by rounding off any fractional part thereof to next higher integer, shall be considered for IA.

*Students should do activity as per the list of suggested activities/ similar activities with prior approval of the teacher. Activity process must be initiated well in advance so that it can be completed well before the end of the term and assessed through appropriate Rubrics.

Questions for CIE and SEE will be designed to evaluate the various CLs as per the weightage shown in the following table.

Sl. No.	Cognitive Levels (CL)	Weightage (%)
1	Remembering	30
2	Understanding	30
3	Analyze	15
4	Applying	15
5	Evaluate	10
Total		100

Continuous Internal Evaluation (CIE) pattern

(i) Student Activity (5 marks)

The following student activities or similar activities can be assigned for assessing CIE/IA marks

Sl. No.	Activity
1	Recent trends in medical imaging systems
2	Special considerations in the design of pressure transducers for medical applications
3	The role of wearable devices in biomedical applications
4	A report on principle of thermography, infrared imaging and applications of thermography in diagnostic medicine.
5	A report on circuits for controlling dialysate temperature and working of blood leak detectors used in haemodialysers
6	A visit to hospital or diagnostic centre with the objective of familiarization of working of medical electronics equipment

Execution Mode

1. At least one activity is mandatory for each batch of 4 students; carried throughout the semester and submit the report before the end of the semester.
2. Report shall be qualitative and not to exceed 4 pages.
3. Activity can be carried out off-class; however, demonstration/presentation should be done in the class room.
4. Teacher is expected to observe and record the progress of students' activities
5. Assessment is made based on quality of work as prescribed by the following **rubrics** table.

(ii) Model of rubrics for assessing student activity

Dimension	Scale					Marks (Example)
	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Good	5 Exemplary	
1. Research and gathering information	Does not collect information relate to topic	Collects very limited information, some relate to topic	Collects basic information, most refer to the topic	Collects more information, most refer to the topic	Collects a great deals of information, all refer to the topic	3
2. Full-fills team roles and duties	Does not perform any duties assigned to the team role	Performs very little duties	Performs nearly all duties	Performs almost all duties	Performs all duties of assigned team roles	2
3. Shares work equality	Always relies on others to do the work	Rarely does the assigned work, often needs reminding	Usually does the assigned work, rarely needs reminding	Always does the assigned work, rarely needs reminding.	Always does the assigned work, without needing reminding	5
4. Listen to other team mates	Is always talking, never allows anyone to else to speak	Usually does most of the talking, rarely allows others to speak	Listens, but sometimes talk too much,	Listens and talks a little more than needed.	Listens and talks a fare amount	3
Total marks						ceil(13/4)= 4

(iii) CIE/IA Tests (20 Marks)

Three tests have to be conducted, during specified schedule, in accordance with the test pattern given below and their average-marks shall be considered for CIE/IA.

(iv) Format of CIE/IA test question paper

CIE Question Paper							
Institution Name and Code							
Course Coordinator/Teacher							
Program Name		Test No.	1	Units			
Class/Sem		Date		CL			
Course Name		Time		COs			
Course Code		Max. Marks		POs			
Note to students: Answer all questions							
Question No.	Question			Marks	CL	CO	PO
1							
2							
3							
4							

Legends: PO-Program Outcome, CO-Course outcome, CL-Cognitive Level, R-Remember, U-Understand, A-Apply

Note: Internal choice may be given in each CO at the same cognitive level (CL).

(v) Model question paper for CIE

CIE Question Paper					
Institution Name and Code					
Course Co-ordinator/Teacher					
<i>Program Name</i>	Electronics and Communication	<i>Test No.</i>	1	<i>Units</i>	1 & 2
<i>Class/Sem</i>	6 th Sem	<i>Date</i>	16/8/2016	<i>CL</i>	R/U/A
<i>Course Name</i>	Medical Electronics	<i>Time</i>	10-11AM	<i>COs</i>	1 & 2
<i>Course Code</i>	15EC6xT	<i>Max. Marks</i>	20	<i>POs</i>	1, 2 & 3
Note to students: Answer all questions					
No.	Question	Marks	CL	CO	PO
1	Explain a typical ECG waveform	05	R/U	1	1,2,3
2	List the factors on which the selection of a physiological transducer depends	05	R/A	1	1,2
3	Sketch the block diagram of a typical EEG machine	05	R/U	2	1,2
4	List the applications of ECG and EMG	05	R/A	2	1,2

Semester end-exam evaluation (SEE)

(i) End-exam question-paper pattern

Unit No.	Unit Name	Study Duration (Hrs.)	No. Questions for End-exam	
			5 Marks PART - A	10 Marks PART - B
1	Bioelectric signals	8	1	1.5
2	Bio potential Recorders	8	2	1.5
3	Therapeutic Equipment	10	2	2
4	Measurement and analysis techniques	10	2	2
5	Imaging systems	9	1	2
6	Biotelemetry and patient safety	7	1	1
	Total	52	09 (45 Marks)	10 (100 Marks)

(ii) Model question paper

Course Title : **Medical Electronics**

Course Code : **15EC6xT**

Time : **3 Hrs**

Semester : **Sixth**

Max. Marks: **100**

Instructions: 1. Answer any **SIX** question from **Part A** (5x6=30 Marks)

2. Answer any **SEVEN** full questions from **Part B** (7x10=70 Marks)

Part A

1. List the factors that decide the selection of a physiological transducer

2. Explain the working of a basic recording system
3. Discuss the necessity of a isolated preamplifier in a ECG machine.
4. Differentiate between internal and external pacemakers
5. List the applications of lasers in medicine
6. Sketch the block diagram of a dark field type blood cell counter.
7. Compare direct and indirect methods of BP measurements
8. Explain the principle of obtaining M-mode display in ultrasound scanning
9. List the measures to be taken to minimize shock hazards in hospitals.

Part B

1. Write the frequency range and suggest a suitable transducer for the following signals
(i) arterial BP(direct) (ii) Cardiac output (iii) body temperature (iv) phonocardiogram (v) ballistocardiogram (10)
2. (a) Explain the different types of electrodes used in EMG recordings. (5)
(b) list the effects of artifacts on ECG recordings (5)
3. Describe the 10-20 system of electrodes used in EEG . (10)
4. Explain the working of a programmable pacemaker(10)
5. (a) Sketch the block diagram of a fibre optic gastric photocoagulator (4)
(b) Explain the working of a digital hearing aid (6)
6. (a) Define MCV, MCH, MCHC, MPV and RDW. (10)
(b) Sketch the block diagram of finger tip oximeter (4)
7. Explain any method of Bp measurement (10)
8. Explain the working of a CT machine and list its advantages(8 + 2)
9. (a) Describe with a block diagram, the working of echocardiograph equipment (8)
(b) List the applications of echocardiograph (2)
10. (a) Define biotelemetry.(2)
(b) Describe the setup of a single channel biotelemetry system used for ECG(8)

Institutional activities (No marks)

The following are suggested institutional activities, to be carried out at least one during the semester. The course teacher/coordinator is expected to maintain the relevant record (Containing, Activity name, Resource persons and their details, duration, venue, student feedback, etc) pertaining to Institutional activities.

Sl. No.	Activity
1	Organize seminar, workshop or lecture from experts on recent developments in the field of medical electronics
2	Arrange field trips to reputed medical hospitals and diagnostic laboratories so that the students get a first hand knowledge of the medical equipments used.

Model Question Bank

Note: The questions in the question bank are indicative but not exhaustive. Sub-questions on different CLs may be combined in 10-marks questions or 10-marks questions can be splitted into if necessary keeping weightage of CLs approximately intact.

UNIT-1

5-mark questions

1. Define resting and action potentials. State the typical values.
2. List the factors on which the selection of a physiological transducer depends .

3. Describe the origin of ECG waveform
4. Suggest suitable transducers for monitoring oxygen level in blood and blood flow
5. State the frequency/amplitude range and transducers to be used for the following signals
 - (i) Ballistocardiogram
 - (ii) PH
6. Write a note on EEG wave patterns
7. Explain the different types of electrodes used in ECG recording

10-mark Questions

1. Write the frequency range and suggest a suitable transducer for the following signals
 - (i) arterial BP (direct)
 - (ii) Cardiac output
 - (iii) body temperature
 - (iv) phonocardiogram
 - (v) ballistocardiogram
2.
 - (a) Explain the different types of electrodes used in EMG recordings. (5)
 - (b) Explain briefly a typical EMG waveform
3. Explain the process of depolarization and repolarisation with a neat diagram.

UNIT-2

5-mark questions

1. Sketch the block diagram of a EEG equipment
2. Explain the working of a basic recording system
3. Justify the presence of isolated preamplifiers in ECG equipments
4. List the applications of EEG and EMG
5. List the effects of artifacts in ECG measurement.
6. Explain the types of bipolar leads used in ECG

10-mark Questions

1. Explain the block diagram of a typical ECG equipment. List the uses of ECG
2. Describe the working of EEG equipment
3. Explain how EMG recordings are made?. list the uses of EMG
4. Describe 10-20 system of EEG electrodes

UNIT-3

5-mark Questions

1. Differentiate between internal and external pacemakers
2. Write the block diagram of gastric photocoagulator
3. Explain the different types of waveforms used in electrotherapy
4. Sketch the schematic of a microwave diathermy setup
5. Differentiate between external and internal defibrillators

10-mark Questions

1. Describe the working of haemodialyser machine
2. State the need for electrotherapy. Explain the working of electrotherapeutic stulator
3.
 - (a) list the advantages of diathermy over conventional heating pads(4)
 - (b) Explain the working of a digital hearing aid(6)
4. Explain the working of a programmable pacemaker

UNIT-4

5-mark Questions

1. Differentiate between direct and indirect method of BP measurement
2. Sketch the block diagram of dark field type blood cell counter
3. Write the block diagram of coulter's type blood cell counter.
4. Explain the role of korotkoff's sounds in BP measurements
5. Write the block diagram of electromagnetic type blood flow meter

10-mark Questions

1. Define PH. Explain the working of digital PH meter
2. Explain the working coulter's type blood cell counter. List its advantages and disadvantages
3. Describe the working dark field type blood cell counter. List its advantages and disadvantages
4. Define MCHC. Explain the working of spectrophotometer
5. Explain the working of spectrophotometer. List its advantages
6. Describe ultrasonic doppler shift method of measuring BP
7. (a) Define MPV and RDW(4)
(b) Describe the working of FHR monitor
8. Explain the working of electromagnetic blood flow meter and list its applications.

UNIT-5

5-mark Questions

1. List the properties of X-rays
2. List the properties of ultrasound
3. Mention the advantages, disadvantages and applications of X-ray imaging machine
4. Sketch the block diagram of x-ray imaging machine
5. list the advantages, disadvantages and applications of CT scan machine
6. Sketch the block diagram of CT scan machine
7. Describe the principle of obtaining M-mode display
8. Explain B-scan in ultrasound scanning
9. List the applications of echocardiograph
10. Write the block diagram of MRI scanner
11. list the advantages, disadvantages and applications of MRI scanner
12. Sketch the block diagram of a basic ultrasound pulsed echo scanner
13. list the advantages, disadvantages and applications of Ultrasound scanning

10-mark Questions

1. Explain the operation of ultrasound pulsed echo scanner
2. Describe the working of echocardiograph. List its applications
3. Explain the working of MRI scanner
4. Explain the working of CT scanner. list its advantages
5. Explain the operation of X- ray imaging machine. List its applications

UNIT-6

5-mark Questions

1. List the essential parameters of telemedicine
2. List the applications of telemedicine
3. List the ill effects of e-waste
4. Define e-waste. Explain any two methods of disposing e-waste
5. Classify the medical devices as per the safety standards
6. Write the physiological effects of radiation exposure
7. Explain micro shock and macro shock
8. List the preventive measures to prevent shock hazards in hospitals
9. Explain the physiological effects of electric current

10-mark Questions

1. Explain telemedicine using mobile communication
2. Define biotelemetry. Describe the working of single channel biotelemetry system used for ECG

End