GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Diploma

Branch: Biomedical Engineering

Course / Subject Code: DI01C03031 (Only for C to D Students)

Course/Subject Name: Basics of Medical Electronics

w. e. f. Academic Year:	2024-25
Semester:	1st
Category of the Course:	ESC-02

Prerequisite:	Basic knowledge of Electronics
Rational:	Biomedical engineering technologists must use/maintain various types of biomedical equipment which are electronically operated and controlled. For using/maintaining such equipment, basics of medical electronics are to be applied in many situations to arrive at the probable solutions to many of the broadly defined problems which they will face during their career as technologists. Therefore, the knowledge about the functions of various basic medical electronics devices and the associated circuits including the associated practical skills acquired through the laboratory will help the student when s/he will be working with electronically controlled/operated biomedical equipment or electronic circuits. This course is therefore so designed that the students will be able to use/apply the principles of basics of medical electronics whenever required in life.

Course Outcome:

After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level
CO-1	Apply fundamental electrical concepts and laws to analyse circuit.	A
CO-2	Illustrate the basic concepts and working principles of passive components.	U
CO-3	Interpret operation of various types of diodes and their application as rectifier.	R
CO-4	Explain transistor applications as amplifiers and switches.	U
CO-5	Illustrate the applications of electronic components in medical field.	A

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
2	0	2	3	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1	**Basics of Electrical Engineering** 1.1. Definition & Units of following terms • Voltage • Current • Amplitude • Frequency • Time Period • Wavelength • Power 1.2. Ohm's law • State Ohm's law • Explain Ohm's law with example 1.3. Kirchhof's Current law (KCL) • State KCL • Explain KCL with example 1.4. Kirchhof's Voltage law (KVL) • State KVL • Explain KVL with example 1.5. Circuit related terminologies • Node • Junction • Branch • Loop (Mesh) • Circuit • Types of Circuit	6	20

2.	**Electronic Components**	8	25
	2.1 Active & Passive Components • Definition of Active & Passive Components • Enlist different Active & Passive Components • Comparison between Active & Passive Components		
	2.2 Active & Passive Components • Definition of Active & Passive Components • Enlist different Active & Passive Components • Comparison between Active & Passive Components 2.3 Resistor • Definition • Formula • Factors affecting resistance • Series & Parallel combination of Resistor • Classification of Resistor 2.4 Capacitor • Definition • Working of Capacitor • Classification of Capacitor • Uses of Capacitor 2.4 Inductor • Definition • Working of Inductor • Uses of Inductor		
3	**Diode theory & rectifiers**	8	25

	3.1 Structure of an atom 3.2 Comparison between conductor, semiconductor & insulator 3.3 Semiconductor • Intrinsic Semiconductor • Extrinsic Semiconductor • Concept of Doping • P-type Semiconductor • N-type Semiconductor • Symbol • Concept of Forward Bias & Reverse Bias • Working of PN Junction Diode • V-I Characteristics of Diode • Uses of Diode Special Diode • LED • Photodiode • Zener Diode		
	3.5 Rectifier Circuit • Rectifier basic • Types of Rectifiers • Working of Half Wave Rectifier • Working of Full Wave bridge Rectifier		
4.	**Transistors**	4	20
	4.1.Transistor • Definition • Symbol of NPN & PNP Transistors • Working principle of NPN Transistor • Common Emitter Configurations of Transistor: Circuit Diagram, Input & Output Characteristics • Common Emitter (CE) Amplifier using Transistor • Transistor as a switch		
5.	**Application of Electronics Components in Medical Field**	4	10

	5.1. Application of Inductor & Capacitor in Medical Field • MRI Machine • Ultrasound Machine • Implantable Medical Device • Wearable Medical Device • Signal Conditioning & Processing 5.2. Application of Transistor in Medical Field • ECG Machines • Pacemakers • Hearing Aids • Infusion Pumps • Medical Imaging Devices		
	Total	**30**	**100 %**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
40 %	40 %	20 %	--	--	--

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Fundamentals of Medical Electronics - A Textbook for Fundamental Electronic Concepts and Circuits Used in Biomedical Instrumentation by P.V.Kumar, 1st edition, White Falcon Publishing, ISBN: 979-8892223256
2. Troubleshooting Electronic Equipment by R S Khandpur Publisher McGraw-Hill Education TAB ISBN-10: 0071477314
3. Principles of Electronics by V K Mehta & Rohit Mehta, 12th Edition, S Chand Publishing, ISBN: 9789352838363
4. A Textbook of Applied Electronics by R S Sedha,3rd Editon, S Chand Publishing, ISBN: 9788121927833
5. Electronic Devices And Circuit Theory by Robert Boylestad And Louis Nashelsky, Pearson Education India, ISBN: 9332542600
6. Electronic Troubleshooting, Fourth Edition Paperback – Illustrated, 16 July 2014 by Daniel Tomal (Author), Aram Agajanian (Author)

(b) Open-source software and website:

1. https://www.electronicsforu.com/special/cool-stuff-misc/open-source-circuit-design-software
2. https://ngspice.sourceforge.io/
3. https://hackaday.com/2023/07/30/an-open-source-free-circuit-simulator/
4. http://opencircuitdesign.com/
5. https://onlinecourses.nptel.ac.in/noc21_ee55/preview
6. https://nptel.ac.in/courses/108102191
7. https://youtu.be/uyOfBPJABtY?si=eEKXFS48jxbKfEcy

Suggested Course Practical List: If any

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. hours required
1	Study Of Various Analog Electronics Terminology and symbols	I	02
2	Measure the value of different types of resistors using color coding and multimeter	II	02
3	Calculate resultant resistor value for Series And parallel connection of resistors and capacitors.	II	02
4	Verify Ohm's Law	I	02
5	Identify different types of capacitors	II	02
6	Measurement of various electrical parameters using a Digital Multimeter	I	02
7	Measure the amplitude & frequencies of different waveforms using CRO	I	02
8	Test VI characteristics of PN junction diode.	III	02
9	Demonstrate Kirchhoff's' current law (KCL) and Kirchhoff's voltage law (KVL)	III	02
10	Build/test half wave rectifier.	III	02
11	Build/test full wave bridge rectifier using Four diodes.	III	02
12	Demonstrate operation of Photodiode.	III	02
13	Demonstrate operation of transistor as switch	IV	02
14	Demonstrate operation of Relay and Fuse	V	02
15	Testing of Active and Passive Components	V	02
	Total Hrs		**30**

List of Laboratory/Learning Resources Required:

The major equipment/instruments and software required to develop PrOs are given below, with broad specifications to facilitate their procurement by the administrators/management of the institutes. This will ensure the conduction of practical skills in all institutions across the state properly so that the desired skills are developed in students.

1. Variable DC power supply: 0-30V, 2A, protection, display for voltage and current.
2. Cathode Ray Oscilloscope: Dual Trace 20Mhz,1 Mega Ω Input Impedance
3. Function Generator: 0-2 MHz with Sine, square and triangular output with variable frequency and amplitude.
4. Digital Multimeter:3 1/2 digit display, 9999 count digital multimeter measures: Vac and Vdc (1000Vmax), Adc and Aac(10 amp max), Resistance (0 - 100M Ω), Capacitance and Temperature measurement
5. Electronic Workbench: 0-30V, 2 Amp Variable DC power supply, Function Generator-2MHz, CRO 0-30MHz or DSO 50MHz minimum Dual channel atleast, Digital Multimeter.
6. Bread Board 840-1000 contact points: Positive and Negative power rails on opposite sides of the board
7. Display board for different types of Resistors
8. Display board for different types of Inductors
9. Display board for different types of Capacitors
10. Display board for different types of Diodes
11. Display board for different types of Transistors

Suggested Project List:

The projects serve as practical learning experiences for students in the field of Biomedical Engineering. These projects integrate theoretical knowledge with hands-on application, fostering competency development across various Course Outcomes (COs). Below are guidelines for designing and executing projects:

- **Project Types:**
  - It can be industry-based, workshop-based, laboratory-based, or field-based.
  - Each project should align with specific COs and address real-world challenges.
- **CO Integration:**
  - It should encompass two or more COs.
  - Integration involves aligning Program Outcomes (PrOs), Unit Outcomes (UOs), and Assessment and Design Outcomes (ADOs).
- **Project Duration:**
  - Students are encouraged to maintain a dated work diary to document their individual contributions and sufficient engagement time for each project should be allocated by faculty during the course.

- **Project Demonstration:**
  - Before submission, students must give a project demonstration on their project.
  - The presentation should highlight the project's objectives, methodology, results, and relevance to industry-oriented COs.
- **Seminar Presentation:**
  - Before submission, students must give a seminar presentation on their project.
  - The presentation should highlight the project's objectives, methodology, results, and relevance to industry-oriented COs.

Following are suggestive projects, and additional ones can be tailored to specific course objectives. Encourage students to explore innovative solutions and apply their engineering skills effectively.

Using various fundamental knowledge of electrical and electronics engineering students may develop mini/micro projects based on team/individual basis which concrete their fundamentals of electronics hardware and can work as prototypic models in various societal applications.

1. **LED Blinking Circuit:**
   - Learn to use a simple 555 timer IC to make an LED blink at a certain frequency.
   - Prepare report and demonstrate circuit
2. **Light Sensor Circuit::**
   - Create a circuit using a light-dependent resistor (LDR) to detect light levels and switch an LED on or off accordingly.
   - Prepare a light sensor circuit on PCB or Bread boar for identified application
   - Prepare report and demonstrate circuit
3. **Basic Temperature Alarm System:**
   - Use NTC Thermistor as temperature sensor.
   - Measure resistance of Thermistor over span of temperature
   - Connect Thermistor in Wheatstone Bridge circuit and measure output over span
   - Calibrate circuit as per temperature specification.
   - Draw characteristics of Thermistor Resistance over temperature
   - Prepare a detailed report summarizing your choices.
4. **Basic Alarm System:**
   - Use a basic electromagnetic or piezo buzzer along with a switch and a power source to create a simple alarm system.
   - Prepare a detailed report summarizing your choices.

5. **Design Positive Power Supply:**
    - Choose a specific type of Positive voltage regulator IC LM78** series
    - Select transformer for rated supply
    - Build full wave bridge rectifier
    - Calculate required capacitor value as per specified output voltage
    - Connect voltage regulator at output of capacitor
    - Measure output of LM78** voltage regulator ic
    - Provide recommendations based on your analysis.
    - Prepare report and demonstrate circuit
6. **Design Negative Power Supply:**
    - Choose a specific type of Positive voltage regulator IC LM79** series
    - Select transformer for rated supply
    - Build full wave bridge rectifier
    - Calculate required capacitor value as per specified output voltage
    - Connect voltage regulator at output of capacitor
    - Measure output of LM79** voltage regulator ic
    - Provide recommendations based on your analysis.
    - Prepare report and demonstrate circuit
7. **Design Positive Variable Power Supply:**
    - Choose a specific type of Positive voltage regulator IC LM317
    - Select transformer for rated supply
    - Build full wave bridge rectifier
    - Calculate required capacitor value as per specified output voltage
    - Connect voltage regulator at output of capacitor
    - Measure output of LM317 voltage regulator ic
    - Vary the output voltage of LM317 by varying potentiometer.
    - Provide recommendations based on your analysis.
    - Prepare report and demonstrate circuit

8. **Collect original different types of Resistors, , Inductors, Capacitors, Diodes and Transistor and display them with their work**

Suggested Activities for Students: If any

In addition to classroom and laboratory learning, students are encouraged to engage in co-curricular activities that enhance their understanding and practical skills. These activities can be

conducted in groups on breadboard or PCB should be used and it should be documented in 5-page reports. Collecting physical evidence of their work will also contribute to their portfolio, which can be valuable during placement interviews.

- Prepare charts/display boards of some electronic devices with their specification.
- Undertake mini/micro-projects in teams/individual basis
- Give seminars on any relevant topic.
- Undertake a market survey of various types of Hardware components.
- Prepare showcase portfolios.
- Collaborate in groups to create detailed specifications for various electronics measuring devices. Consider units, accuracy, tolerance, specifications etc.
- Form teams and work on small-scale electronics projects. Apply theoretical knowledge to practical scenarios, such as designing a fixed or variable power supply and setup.
- Deliver a seminar on safety practices specific to electronics systems. Cover topics like testing and troubleshooting of electronics equipment
- Conduct a comprehensive market survey to explore available electronics components' of different types of Resistors, Inductor, Capacitors, Diodes, Transistors, NTC and PTC Thermistor etc.). Analyze their features, costs, and suitability for different applications.
- Prepare portfolios showcasing your electronics-related work. Include project reports, photographs, and evidence of practical implementation.

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