Gyanmanjari Innovative University

Syllabus
Gyanmanjari Institute of Technology
Semester-1 (B.Tech)

Subject: Basics of Electronics Engineering: Concepts and Applications - BET2EE11301

Type of course: Engineering Science Courses

Prerequisite: Basic knowledge of Science and logical thinking.

Rationale: This course introduces first-year engineering students to the fundamentals of electronics through simulation-based and hands-on learning. It enables students to understand the operation of semiconductor devices, transistor switching circuits, Arduino-based interfacing, sensors, and actuators using Multisim, Tinkercad, and breadboard-based experiments. The course emphasizes practical problem-solving, system integration, and engineering design through real-world applications and a mini project, providing a strong foundation for advanced courses in Electronics, Embedded Systems, IoT, Robotics, and Automation while fostering innovation, teamwork, and technical skills across all engineering disciplines.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks		Total Marks
CI	T	P	C	SEE	CCE	
2	0	4	4	100	50	150

Legends: CI-Class Room Instructions; T – Tutorial; P - Practical; C – Credit; SEE - Semester End Evaluation; CCE-Continuous and Comprehensive Evaluation.

Course Content:

Sr. No.	Course Content	Hrs.	% Weightage
1	**Semiconductor Diodes and Their Applications** ***Theory Topics:*** Introduction to Semiconductor Materials, Intrinsic and Extrinsic Semiconductors, P-Type and N-Type Semiconductors, PN Junction Diode, Forward and Reverse Bias, V-I Characteristics of Diode, Zener Diode, LED, Photodiode, Half Wave Rectifier, Full Wave Rectifier, Bridge Rectifier, Clipper and Clamper Circuits, Zener Voltage Regulator, Applications of Semiconductor Diodes, Introduction to Multisim, Simulation of Diode Circuits, Breadboard Implementation, Measurement	18	25%

using Digital Multimeter (DMM) and CRO, Testing and Troubleshooting of Diode Circuits.

Practical:

1. Simulate the V-I characteristics of a PN junction diode under forward and reverse bias conditions using Multisim.
2. Design and simulate a Half Wave Rectifier and observe the input and output waveforms.
3. Design and simulate a Full Wave Bridge Rectifier with a filter capacitor and analyze ripple reduction.
4. Design and simulate positive and negative clipper circuits using semiconductor diodes.
5. Construct and test a Half Wave Rectifier using discrete electronic components on a breadboard.
6. Construct a Full Wave Bridge Rectifier and measure the output voltage using a Digital Multimeter.
7. Build an LED indication circuit using a current-limiting resistor and verify diode polarity.
8. Construct a Zener voltage regulator circuit and measure the regulated output voltage.
9. Compare the simulated and practical results of rectifier circuits and prepare a technical observation report highlighting differences.

Evaluation Method

Sr. No.	Evaluation Methods	SEE	CCE
1	**Design, Simulation and Hardware Implementation of Diode Circuits:** Students will design, simulate, construct, and test an assigned diode application circuit such as Half Wave Rectifier, Full Wave Rectifier, Bridge Rectifier, Clipper, Clamper, or Zener Voltage Regulator using Multisim and breadboard. Students will verify circuit operation using measuring instruments, analyze the obtained results, and demonstrate the practical application of the circuit.	20	
2	**Active Learning Assignment: Simulation and Experimental Analysis of Semiconductor Diodes:** Students will perform simulations using Multisim, implement the selected diode circuit on a		10

		breadboard, record voltage and waveform observations, compare simulation and practical results, identify sources of error, and compile the complete experiment including circuit diagrams, simulation screenshots, observations, and conclusions into a PDF report for submission through the GMIU Portal.				
		Total	**20**	**10**		

Examination Style:

Semiconductor Diode Circuit Design, Simulation and Implementation (20 Marks)

Students will receive a diode circuit design problem from the faculty to design, simulate, construct, and test using Multisim and a breadboard. The assigned task may include a Half Wave Rectifier, Full Wave Rectifier, Bridge Rectifier, Clipper, Clamper, or Zener Voltage Regulator circuit. Students shall verify the circuit operation using a Digital Multimeter (DMM) and CRO, analyze the input and output characteristics, compare the simulation and practical results, and explain the engineering applications of the implemented circuit.

Active Learning Assignment: Diode Circuit Analysis using Multisim and Breadboard (10 Marks)

Students shall perform an experimental activity by simulating a diode application circuit in Multisim and implementing the same on a breadboard using electronic components. The activity includes circuit design, testing, measurement of voltages, comparison of simulation and practical observations, troubleshooting of basic faults, and preparation of a concise technical report containing the circuit diagram, simulation screenshots, observations, and conclusion. The report shall be submitted through the GMIU Portal.

2	**Bipolar Junction Transistors and Switching Applications** ***Theory Topics:*** Introduction to Bipolar Junction Transistor (BJT), Construction and Working of NPN and PNP Transistors, Transistor Terminals and Symbol, Current Flow in BJT, Transistor as a Switch, Switching Characteristics, Transistor Specifications and Datasheets, Relay Driver Circuit, Transistor-Based LED Driver Circuit, Transistor-Based Buzzer Circuit, Introduction to Optocoupler, Practical Applications of BJT in Electronic	**18**	**15%**

Circuits, Introduction to Multisim for Transistor Circuit Simulation, Simulation of Switching Circuits, Breadboard Implementation of BJT Applications, Testing and Troubleshooting using Digital Multimeter (DMM).

Practical:

10. Simulate the switching characteristics of an NPN transistor using Multisim and observe its ON and OFF states.
11. Design and simulate a transistor-based LED driver circuit using Multisim.
12. Design and simulate a transistor-operated relay driver circuit and analyze its switching operation.
13. Design and simulate a transistor-based buzzer control circuit using Multisim.
14. Construct an NPN transistor switch on a breadboard and verify its switching operation using a Digital Multimeter (DMM).
15. Construct a transistor-based LED driver circuit on a breadboard and analyze its performance.
16. Construct a relay driver circuit using a transistor to control an external load and verify its operation.
17. Construct a transistor-controlled buzzer circuit using discrete electronic components on a breadboard.
18. Compare the simulated and practical performance of transistor switching circuits by recording and analyzing the observations.

Evaluation Method

Sr. No.	Evaluation Methods	SEE	CCE
1	**Design, Simulation and Hardware Implementation of BJT Switching Circuits:** Students will design, simulate, construct, and test a transistor switching application such as an LED driver, relay driver, or buzzer control circuit using Multisim and a breadboard. Students will verify the circuit operation, analyze the results, and demonstrate the practical application.	20	
2	**Active Learning Assignment: Simulation and Experimental Analysis of BJT Switching Circuits:** Students will simulate the assigned transistor circuit using		10

		Multisim, implement it on a breadboard, record observations, compare simulation and hardware results, troubleshoot basic faults, and submit a technical report containing circuit diagrams, screenshots, observations, and conclusions through the GMIU Portal.			
		Total	**20**	**10**	

Examination Style

BJT Switching Circuit Design, Simulation and Implementation (20 Marks)

Students will receive a transistor switching circuit problem from the faculty to design, simulate, construct, and test using Multisim and a breadboard. The assigned task may include an LED driver, relay driver, transistor switch, or buzzer control circuit. Students shall verify circuit operation using a Digital Multimeter (DMM), analyze the switching behavior, compare simulation and practical results, and explain the engineering application of the implemented circuit.

Active Learning Assignment: BJT Switching Circuit Analysis using Multisim and Breadboard (10 Marks)

Students shall perform an experimental activity by simulating a transistor switching circuit in Multisim and implementing the same on a breadboard using electronic components. The activity includes circuit design, testing, troubleshooting, comparison of simulation and practical observations, and preparation of a concise technical report containing the circuit diagram, simulation screenshots, observations, and conclusion. The report shall be submitted through the GMIU Portal.

3	**Arduino Platform and Embedded Interfacing** ***Theory Topics:*** Introduction to Embedded Systems, Introduction to Arduino Platform, Arduino Uno Board Architecture, Features and Specifications of Arduino Uno, Arduino IDE Installation and Interface, Structure of an Arduino Program, Digital Input and Digital Output, Analog Input and PWM Output, Serial Monitor, Interfacing of LED, Push Button, Buzzer, Potentiometer and Servo Motor with Arduino, Introduction to Tinkercad Circuits, Simulation of Arduino-Based Circuits using Tinkercad, Breadboard Implementation of Arduino Interfacing Circuits, Testing and Troubleshooting of Arduino Circuits. ***Practical:***	**18**	**20%**

19. Install the Arduino IDE, configure the Arduino Uno board, and upload the first LED blinking program.
20. Create and simulate an LED blinking circuit using Tinkercad Circuits.
21. Interface multiple LEDs with Arduino and implement different LED blinking patterns.
22. Interface a push button with Arduino to control an LED.
23. Interface a buzzer with Arduino and generate different sound patterns.
24. Interface a potentiometer with Arduino and control the brightness of an LED using PWM.
25. Interface a servo motor with Arduino and control its angular position.
26. Display analog and digital input values on the Serial Monitor.
27. Construct and test the simulated Arduino circuits on a breadboard and compare the simulation and practical observations.

Evaluation Method

Sr. No.	Evaluation Methods	SEE	CCE
1	**Arduino Circuit Design, Simulation and Hardware Implementation:** Students will design, simulate, construct, and test an Arduino-based interfacing circuit using Tinkercad and a breadboard. The assigned task may include LED control, push button interfacing, buzzer control, potentiometer-based LED brightness control, or servo motor control. Students shall verify the circuit operation, analyze the results, and demonstrate the practical application.	20	
2	**Active Learning Assignment: Arduino Interfacing using Tinkercad and Breadboard:** Students will simulate an Arduino interfacing circuit using Tinkercad, implement the same on a breadboard, record observations, compare simulation and hardware results, troubleshoot basic faults, and prepare a technical report containing circuit diagrams, simulation screenshots, observations, and conclusions for submission through the GMIU Portal.		10
	Total	20	10

	Examination Style **Arduino Circuit Design, Simulation and Hardware Implementation (20 Marks)** Students will receive an Arduino interfacing problem from the faculty to design, simulate, construct, and test using Tinkercad and a breadboard. The assigned task may include LED blinking, push button interfacing, buzzer control, potentiometer-based LED brightness control, servo motor interfacing, or Serial Monitor applications. Students shall verify the circuit operation, upload the Arduino program, compare simulation and practical results, and explain the engineering application of the implemented circuit. **Active Learning Assignment: Arduino Interfacing using Tinkercad and Breadboard (10 Marks)** Students shall perform an experimental activity by simulating an Arduino circuit in Tinkercad and implementing the same on a breadboard using Arduino Uno and electronic components. The activity includes circuit design, program development, testing, troubleshooting, comparison of simulation and practical observations, and preparation of a concise technical report containing the circuit diagram, Arduino code, simulation screenshots, observations, and conclusion. The report shall be submitted through the GMIU Portal.		
4	**Sensors and Actuators for Engineering Applications** ***Theory Topics:*** Introduction to Sensors and Actuators, Classification of Sensors, Analog and Digital Sensors, Characteristics of Sensors, Introduction to LDR, IR Sensor, Ultrasonic Sensor, Temperature Sensor (LM35/DHT11), Introduction to Actuators, LED, Buzzer, Relay, DC Motor, Servo Motor, Sensor and Actuator Interfacing with Arduino, Engineering Applications of Sensors and Actuators, Simulation of Sensor-Based Circuits using Tinkercad, Breadboard Implementation of Sensor and Actuator Circuits, Testing and Troubleshooting of Interfacing Circuits. ***Practical:*** 28. Interface an LDR sensor with Arduino and control an LED based on ambient light intensity. 29. Interface an IR sensor with Arduino for object detection and LED indication. 30. Interface an ultrasonic sensor with Arduino and display the measured distance on the Serial Monitor.	**18**	**20%**

31. Interface a temperature sensor (LM35/DHT11) with Arduino and monitor the temperature.
32. Interface a relay module with Arduino to control an external load.
33. Interface a DC motor with Arduino using a motor driver and control its operation.
34. Interface a servo motor with Arduino and control its angular position based on sensor input.
35. Simulate sensor and actuator interfacing circuits using Tinkercad and verify their operation.
36. Construct the simulated sensor and actuator circuits on a breadboard and compare the simulation and practical observations.

Evaluation Method

Sr. No.	Evaluation Methods	SEE	CCE
1	**Sensor and Actuator Interfacing, Simulation and Hardware Implementation:** Students will design, simulate, construct, and test an assigned sensor or actuator interfacing circuit using Tinkercad, Arduino, and a breadboard. The assigned task may include interfacing an LDR, IR, ultrasonic, temperature sensor, relay, DC motor, or servo motor. Students shall verify the circuit operation, analyze the results, and demonstrate its engineering application.	20	
2	**Active Learning Assignment: Sensor and Actuator Interfacing using Tinkercad and Breadboard:** Students will simulate the assigned interfacing circuit using Tinkercad, implement it on a breadboard using Arduino and electronic components, record observations, compare simulation and practical results, troubleshoot basic faults, and prepare a technical report containing circuit diagrams, simulation screenshots, observations, and conclusions for submission through the GMIU Portal.		10
	Total	20	10

Examination Style

	Sensor and Actuator Interfacing, Simulation and Hardware Implementation (20 Marks) Students will receive a sensor or actuator interfacing problem from the faculty to design, simulate, construct, and test using Tinkercad, Arduino, and a breadboard. The assigned task may include interfacing an LDR, IR sensor, ultrasonic sensor, temperature sensor, relay, DC motor, or servo motor. Students shall verify the circuit operation, analyze the input and output response, compare simulation and practical results, and explain the engineering application of the implemented system. **Active Learning Assignment: Sensor and Actuator Interfacing using Tinkercad and Breadboard (10 Marks)** Students shall perform an experimental activity by simulating a sensor or actuator interfacing circuit in Tinkercad and implementing the same on a breadboard using Arduino and electronic components. The activity includes circuit design, testing, troubleshooting, comparison of simulation and practical observations, and preparation of a concise technical report containing the circuit diagram, Arduino program, simulation screenshots, observations, and conclusion. The report shall be submitted through the GMIU Portal.		
5	**Smart Electronic System Design** ***Theory Topics:*** Introduction to Electronic System Design, Block Diagram Development, System Integration using Arduino, Sensors and Actuators, Power Supply Considerations, Circuit Assembly and Breadboard Prototyping, Testing and Troubleshooting Techniques, Simulation and Hardware Verification, Engineering Design Process, Technical Documentation, Team-Based Product Development, Applications of Smart Electronic Systems in Various Engineering Domains. ***Practical:*** 37. Design and simulate an automatic street light system using Arduino and LDR in Tinkercad. 38. Design and simulate an automatic water level indicator using Arduino and suitable sensors. 39. Design and implement a temperature monitoring and alarm system using Arduino and a temperature sensor. 40. Design and implement an automatic object detection and alert system using Arduino and an ultrasonic or IR sensor. 41. Design and implement a smart home lighting control system using Arduino, sensors, and relay modules. 42. Design and simulate an engineering application by integrating at least one sensor and one actuator using Arduino.	**18**	**20%**

43. Test, troubleshoot, and optimize the performance of the developed electronic system.
44. Prepare the circuit diagram, flowchart, and technical documentation of the developed system.
45. Design, develop, demonstrate, and present a Mini Project based on the concepts covered in the course using Arduino, electronic components, sensors, and actuators.

Evaluation Method

Sr. No.	Evaluation Component	SEE (Marks)	CCE (Marks)
1	**Design, Development and Demonstration of a Smart Electronic System:** Students will design, simulate, construct, test, and demonstrate a smart electronic system by integrating Arduino, electronic components, sensors, and actuators using Tinkercad and a breadboard. The developed system shall perform the assigned engineering application and demonstrate proper functionality.	20	
2	**Active Learning Assignment: Smart Electronic System Development:** Students will develop a mini project in a team, prepare circuit diagrams, simulation screenshots, Arduino program, testing results, and technical documentation. The complete report along with observations, photographs, and conclusions shall be compiled into a PDF and submitted through the GMIU Portal.		10
	Total	20	10

Examination Style

Smart Electronic System Design, Development and Demonstration (20 Marks)

Students will receive an engineering problem from the faculty to design, simulate, construct, test, and demonstrate a smart electronic system using Arduino, electronic components, sensors, and actuators. Students shall develop the complete system using Tinkercad and breadboard, verify its operation, troubleshoot hardware and software issues, demonstrate the

	working prototype, and explain its engineering application and design methodology. **Active Learning Assignment: Smart Electronic System Development (10 Marks)** Students shall work individually or in teams to develop a smart electronic system based on the concepts covered in the course. The activity includes system planning, circuit design, simulation, hardware implementation, testing, troubleshooting, technical documentation, and presentation. The final report shall include the block diagram, circuit diagram, Arduino program, simulation screenshots, photographs of the hardware setup, observations, and conclusion, and shall be submitted through the GMIU Portal.		

Suggested Specification Table with Marks:

Distribution of Marks **(Revised Bloom's Taxonomy)**						
Level	Remembrance (R)	Understanding (U)	Application (A)	Analyze (N)	Evaluate (E)	Create (C)
Weightage %	10%	15%	20%	10%	15%	30%

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the evaluation may vary slightly from the above table.

Course Outcome:

After learning the course, the students should be able to:	
CO1	Explain the operation and applications of semiconductor diodes and construct basic diode circuits using simulation software and breadboard.
CO2	Design and implement transistor-based switching circuits using BJT and analyze their performance through simulation and hardware implementation.
CO3	Develop basic Arduino-based interfacing circuits by integrating digital and analog input/output devices using Tinkercad and hardware.
CO4	Interface basic sensors and actuators with Arduino to develop simple engineering applications and evaluate their performance.
CO5	Design, simulate, implement, and demonstrate a smart electronic system by integrating electronic components, Arduino, sensors, and actuators to solve real-world engineering problems.

Instructional Method:

The course delivery method will depend on the content requirements and students' needs. The teacher, in addition to the conventional teaching method by the blackboard, may also use any of the tools, such as demonstration, role play, quizzes, brainstorming, MOOCs, etc.

From the content, 10% of topics are suggested for flipped-mode instruction.

Students will utilise supplementary resources, including online videos, NPTEL/SWAYAM videos, e-courses, and Virtual Laboratories.

The internal evaluation will be done on the basis of the CCE-Continuous and Comprehensive Evaluation.

SEE: Semester End Evaluation will be conducted at the end of each module for the evaluation of the performance of students in the laboratory.

Reference Books

[1] T. L. Floyd, *Electronic Devices*, 10th ed. Noida, India: Pearson Education, 2018.

[2] R. L. Boylestad and L. Nashelsky, *Electronic Devices and Circuit Theory*, 11th ed. Noida, India: Pearson Education, 2013.

[3] P. Scherz and S. Monk, *Practical Electronics for Inventors*, 4th ed. New York, NY, USA: McGraw-Hill Education, 2016.

[4] S. Monk, *Programming Arduino: Getting Started with Sketches*, 2nd ed. New York, NY, USA: McGraw-Hill Education, 2016.

[5] P. Horowitz and W. Hill, *The Art of Electronics*, 3rd ed. Cambridge, U.K.: Cambridge University Press, 2015.