** COMSATS University Islamabad, Lahore Campus**

**Block–B, Department of Electrical Engineering**

**1.5 KM Defence Road, Off Raiwind Road, Lahore**

**Course Descriptive File**

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| **1** | **Course Title** | Electronic Devices and Circuits |
| **2** | **Course Code** | CPE231 |
| **3** | **Credit Hours** | 4(3,1) |
| **4** | **Pre-requisite(s)** | Electric Circuits Analysis I (CPE121) |
| **5** | **Semester** | 4th |
| **6** | **Resource Person** | Miss. Wajeeha Khan |
| **7** | **Lab Instructor** | Miss. Wajeeha Khan |
| **8** | **Contact Hours (Theory)** | 3 hours per week |
| **9** | **Contact Hours (Lab)** | 3 hours per week |
| **10** | **Office Hours** | 9 AM to 1PM (Tuesday) |
| **11** | **email** | wajeehakhan@cuilahore.edu.pk |
| **12** | **Course Outline as per SoS** | |
| Introduction to Semiconductor Materials, Energy levels, Intrinsic Materials, Doping, Extrinsic Materials, N-Type and P-Type, Semiconductor Diode, Biasing, Characteristic Curve, Load Line Analysis, Diode Approximations, Series and Parallel Configurations, Half-Wave/Full-Wave Rectifiers, Clippers and Clampers, LED, Zener Diode Applications, Construction and Operation of DC biasing, MOSFET – Structure and physical operation, device operation, DC biasing, design using DC biasing, Different Configuration, Small-signal models and analysis BJT – Structure and physical operation, Biasing and DC analysis and design, Different Configuration, Small-signal models and analysis. Introduction to Power Amplifiers, Differential Amplifiers, Operational Amplifiers, and Applications. | | |
| **13** | **Course Objectives as per SoS** | |
| The objective of this course is to teach the principles, operations, and characteristics of various electronic devices and their applications in electronic circuits. | | |
| **14** | **Books** | |
| **Textbook**   1. Electronic Devices and Circuit Theory by Boylestad & Nashelsky (11th Edition) PEARSON. 2. Microelectronic Circuits by Adel S. Sedra and Kenneth C. Smith, 6th Edition, Oxford University Press   **Reference Book(s):**   1. Electronic Devices (Conventional Current Version) By Thomas Floyd, 10th Edition, Pearson 2. Electronic Devices and Circuits by Theodore F. Bogart, Jeffrey S. Beasley, and Guillermo Rico, 6th Edition, Pearson 3. Schaum's Outline of Electronic Devices and Circuits by Jimmie J. Cathey, 6th Edition, McGraw-Hill | | |
| **15** | **Course Learning Outcomes (CLOs)** | |
| **Theory CLOs**   1. Explain the structure and operation of electronic devices, particularly diodes, Bipolar Junction Transistors (BJTs), and Field-Effect Transistors (FETs) based on semiconductor theory. (PLO1-C2) 2. Analyze simple DC and AC circuits containing diodes, BJTs, and FETs using standard circuit analysis techniques. (PLO2-C4) 3. Design Zener diode-based voltage regulators and op-amp based circuits by applying the working principles of electronic devices (PLO3-C5)   **Lab CLOs**   1. Design and compute the circuit parameters of small-signal BJT, FET amplifier, and operational amplifier using standard circuit analysis techniques. (PLO3, C5) 2. Construct analog electronic circuits and measure their input, intermediate, and output voltages and currents using simulation tools, hardware platforms (breadboard, PCB, etc.), digital multimeter (DMM), and digital storage oscilloscope (DSO). (PLO5, P4) | | |
| **16** | **Marks Breakup** | |
| |  |  |  |  | | --- | --- | --- | --- | | Quizzes (minimum 4) | | 15% | | | Homework assignments (minimum 4) | | 10% | | | Mid Term Exam (1 hr. 30 minutes) | | 25% | | | Terminal exam (3 hours) | | 50% | | | **Total (theory)** | **100%** | |   **Theory**   |  |  | | --- | --- | | Lab Assessments | 25% | | Mid Term: 0.5\*(Midterm Exam result) + 0.5\*[ (average of lab evaluation of Lab 1-7) \* 2.5] | 25% | | Terminal 0.5\*(Terminal Exam result) +0.25\*[(average of lab evaluation of Lab 9-12) \*5] + 0.10\*[(average of lab evaluation of Lab 5-8) \*5] + 0.15\*[(average of lab evaluation of Lab 1-4) \*5] | 50% | | **Total (lab)** | **100%** |   **Lab**   |  |  | | --- | --- | | **Final marks** | Theory marks \* 0.75 + Lab marks \* 0.25 | | | |

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| **17** | **Lecture Plan** | | | | | | | |
| Week | **Topic** | **CLO** | **Specific Outcome** | **Contact Hours** | **Students Learning Hours** | **Assessment** | **Bloom Taxonomy** |
| 1 | Introduction to Semiconductor Materials, Energy levels, Intrinsic Materials, Doping, Extrinsic Materials, N-Type and P-Type, Semiconductor Diode, Biasing | CLO1 | * 1. **Explain** the concept of minority and majority carriers in P-type and N-type materials **using** theoretical knowledge of semiconductor devices   2. **Explain** the forward and reverse biased behavior of the PN junction diode in an electronic circuit | 3 | 4 | Quiz 1  Assignment 1  Mid Term Exam  Terminal | **C2** |
| 2 | Characteristic Curve, Load Line Analysis, Diode Approximations, Series and parallel configurations | CLO1 | **Explain** diode working principle and forward/reverse biased characteristics to **predict** the output of electronic circuits | 3 | 4 | **C2** |
| 3 | AND/OR Gates, Half-Wave/Full-Wave Rectifiers, | CLO2 | **Differentiate** the output waveforms for different input signals applied to diode-based electronic circuits | 3 | 4 | **C4** |
| 4 | Clippers and Clampers | CLO2 | **Differentiate** the output waveforms for different input signals applied to diode-based electronic circuits | 3 | 4 | **C4** |
| 5 | Special Diodes, Zener Diode Applications | CLO3 | * 1. **Analyze** the Zener diode-based voltage regulators **for** output voltage and power dissipated in the load   2. **Design** Zener diode-based voltage regulator by exploiting the properties of Zener diode | 3 | 4 | **C5** |
| 6 | BJT – Structure and physical operation | CLO2 | **Illustrate** the working of NPN and PNP BJTs **by** **applying** the concept of carrier’s flow in semiconductors | 3 | 4 | Quiz 2  Assignment 2  Mid Term Exam  Terminal | **C4** |
| 7 | Biasing and DC analysis of Common emitter configuration. Common emitter configuration, for fixed-biased Self-biased and voltage divider-biased configuration | CLO2 | **Analyze** different BJT biasing circuits for voltage and current by **applying** mathematical relationships of voltages and currents | 3 | 4 | **C4** |
| 8 | Small signal models and analysis of BJT circuits | CLO2 | **Analyze** BJT circuits for voltage and current gains by **applying** small-signal models | 3 | 4 | **C4** |
| 9 | Midterm | CLO1, CLO2, CLO3 |  |  |  |  |  |
| 9 | Construction and Operation of JFET and DC biasing | CLO2 | **Illustrate** the working of N-channel and P-channel JFETs by **applying** the concept of carrier flow in semiconductors | 3 | 4 | Quiz 3  Assignment 3  Terminal | **C4** |
| 10 | MOSFET – Structure and physical operation, device operation | CLO2 | **Illustrate** the working of NMOS and PMOS by **applying** the concept of carrier flow in semiconductors |  |  | **C2, C4, C5** |
| 11 | DC biasing analysis using DC biasing, Different Configuration | CLO2 | **Analyze** different MOSFET biasing circuits for voltage and current by **applying** mathematical relationships of voltages and currents | 3 | 4 | **C4** |
| 12 | Small signal models and analysis of JFETS and MOSFETS | CLO2 | **Analyze** FETs and MOSFETs circuits for voltage and current gains by **applying** small-signal models | 3 | 4 | Assignment 4  Quiz 4  Terminal | **C4** |
| 13 | Operational Amplifiers – Internal Circuit of Op-Amp, Ideal Op-Amp and its Characteristics | CLO3 | **Formulate** the basic characteristics of an ideal op-amp | 3 | 4 | **C5** |
| 14 | Inverting, Non-inverting and Voltage-Follower Configurations and Circuit design, Adder, Subtractor, Differentiator, and Integrator | CLO3 | 1. **Analyze** inverting, non-inverting and voltage follower op-amp circuits for voltage gain **using** the working principles of op-amp 2. **Design** op-amp based amplifier, differentiator, and integrators **using** op-amp working principles | 3 | 4 | **C5** |
| 15 | **Terminal Examination** | CLO2  CLO3 |  |  |  |  | **C4, C5** |

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| **19** | **Course Learning Outcomes (CLOs) and Assessment Plan** |
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| **20** | **Laboratory Experiences** | |
| There is an integral laboratory component in all 3+1 credit courses taught in the department. Lab work consists of a minimum of 13 experiments, a semester project, and related assignments, which constitute 25% of the overall course grade. Laboratory experiments include hands-on exercises as well as computer-based analysis of the concepts taught in class. This course familiarizes the students with the PSpice analysis software tool, which is a part of all laboratory experiments. | | |
| **21** | **Laboratory Resources** | |
| The relevant laboratory is equipped with workbenches and computers to facilitate the experiments outlined in the lab handbook(s) that are periodically updated. The current list of the 14 lab experiments as part of this course is provided in Annexure-I. The list of software tools and available equipment is also posted in the relevant lab and is managed by the concerned lab staff. | | |
| **22** | **Computer Resources** | |
| PSpice simulation software is used throughout the course for verifying the results of experiments. | | |
| **23** | | **Mapping of CLOs to PLOs** |
| |  | | --- | | PLO1 **Engineering Knowledge:** An ability to apply knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. **(Cognitive)**  PLO2 **Problem Analysis:** An ability to identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. **(Cognitive)**  PLO3 **Design/Development of Solutions:** An ability to design solutions for complex engineering problems and design systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations. **(Cognitive)**  PLO4 **Investigation:** An ability to investigate complex engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis and interpretation of experimental data, and synthesis of the information to derive valid conclusions. **(Cognitive, Psychomotor)**  PLO5 **Modern Tool Usage:** An ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities, with an understanding of the limitations. **(Psychomotor)**  PLO6 **The Engineer and Society:** An ability to apply reasoning formed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solution to complex engineering problems. **(Cognitive)**  PLO7 **Environment and Sustainability:** An ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development. **(Cognitive)**  PLO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice. **(Affective)**  PLO9 **Individual and Team Work:** An ability to work effectively, as an individual or in a team, on multi-faceted and/or multi-disciplinary settings. **(Affective)**  PLO10 **Communication:** An ability to communicate effectively, orally as well as in writing, on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. **(Affective)**  PLO11 **Project Management:** An ability to demonstrate management skills and apply engineering principles to one’s own work, as a member and/or leader in a team, to manage projects in a multidisciplinary environment. **(Affective)**  PLO12 **Life long Learning:** An ability to recognize importance of, and pursue lifelong learning in the broader context of innovation and technological developments. **(Affective)** | | | |

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| **CLOs – PLOs Mapping**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | PLO  CLOs | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 | PLO11 | PLO12 | Cognitive Domain | | | | | | Affective Domain | | | | | Psychomotor Domain | | | | | | C1 | C2 | C3 | C4 | C5 | C6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | | CLO1 | X |  |  |  |  |  |  |  |  |  |  |  |  | X |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | CLO2 |  | X |  |  |  |  |  |  |  |  |  |  |  |  |  | X |  |  |  |  |  |  |  |  |  |  |  |  | | CLO3 |  |  | X |  |  |  |  |  |  |  |  |  |  |  |  |  | X |  |  |  |  |  |  |  |  |  |  |  | | CLO4 |  |  | X |  |  |  |  |  |  |  |  |  |  |  |  |  | X |  |  |  |  |  |  |  |  |  | X |  | | CLO5 |  |  |  |  | X |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | X |  | |

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| **24** | **PLOs Coverage Explanation** |
| **PLO 1 - Engineering Knowledge:**  Introduction to the basic concepts of semiconductor materials, conduction of electric current, concept of electronic and hole current. P-type and N-type materials, PN junction diode, forward and reverse biasing of diode, IV characteristics of PN junction diode.  **PLO 2 - Problem Analysis:**  Analyzing the diode circuits for the values of current, voltage and power dissipation in diodes and resistors, behavior of diode under AC input. Rectifier, clipper and clamper circuit analysis for the output voltage waveforms.  **PLO 3 - Design/Development of Solutions:**  Designing the Zener diode based voltage regulator circuits by applying the working principles of Zener diode. Designing BJT biasing circuits for the required value of quiescent point (Q-point) by applying the concept of different modes of operation of a BJT. Designing Op-amp circuits for inverting and non-inverting amplifiers to achieve required gain by applying the properties of an ideal op-amp.  **PLO4 - Investigation:**  The advance current and voltage measurement tools are used in the laboratory sessions.  **PLO5- Modern Tool Usage:**  The PSpice simulation tool is introduced and used extensively in the laboratory sessions.  **PLO 9 –Individual and Team Work:** Students assemble different parts of the circuit individually and as teamwork in lab experiments performed in the laboratory sessions.  **PLO 10 - Communication:** Students explain and write a report of lab experiments performed in the laboratory sessions.  **PLO 6-8,11,12:** These PLOs are not directly addressed in this course. | |
| **25** | **List of Experiment with Objectives as per OBE Format** |
| |  |  | | --- | --- | | **Lab Experiment No.** | **Title and Objectives** | |  | To understand how to generate a signal using function generator and display using oscilloscope and construct a diode based circuit and display the output using hardware tools | |  | To construct a half wave and full wave rectifier circuit and display the waveform using hardware tools | |  | To construct a Zener diode based circuit and sketch its I-V characteristics | |  | To display the output of diode based clipper circuit using hardware tools. | |  | To display the output of diode based clamper circuit using hardware tools. | |  | To Sketch the input and output characteristics of common base BJT Transistor using hardware tools. | |  | To sketch the input and output characteristics of Common Emitter BJT Transistor using hardware tools. | |  | To measure the quiescent operating point of Fixed and Emitter Biased BJTs using hardware tools. | |  | To construct a voltage-divider biased common-emitter circuit and measure its Q point voltage and current using digital multimeter. | |  | To Design a Voltage-Divider Biased Common-Emitter Amplifier with Fully Bypassed Emitter Resistance and Analyze the effect of Load on its AC Operation Using Hardware and Software Tools | |  | To Construct the Class A Power Amplifier and Compute its Efficiency Using Hardware and Software tools | |  | To Design and Construct the Basic Linear Op-Amp Circuit using Hardware and Software Tools | | |