University of Sargodha
College of Engineering and Technology
Department of Electrical Engineering

**Course Syllabus**
**EE-127: Electronic Devices and Circuits**

**Semester / Session: 2nd/Fall-2019**

**Program: BSc Electrical Engineering**

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**Instructor:** Dr. Ateeq-Ur-Rehman Shaheen
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**Office Hours:** 11: 00 AM to 01: 00 PM (Tue, Thu)

**Schedule (Theory Class):** Monday 12:30 PM to 02:00 PM
Tuesday 08:00 AM to 09:30 AM.

**Course TA:** N.A.

**Course Description:** This course provides a platform for students to understand working of semiconductors devices such as Diode, BJT, and MOSFET, JFET and circuits and systems like amplifiers. Students are also taught to analyze circuits using these semiconductor devices. This is one of the foundation courses which are required for students to understand working of complex electronic circuits and systems.

**Catalog Data:**

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|---|---|
| Course Code: | EE-127 |
| Course Title: | Electronic Devices and Circuits |
| Credit Hours: | 3 |
| Course Designation: | Core |
| No of Sessions per week: | 2 (Total 32 sessions) |
| Session Duration: | 90 min |

**Course Objectives:** The objective of this course is to teach the principle, operation and characteristics of various electronic devices and their applications in electronic circuits.

**Catalog Description:** **EE-127 Electronic Devices and Circuits, Credits (3)**
PN junction, Device physics, Diode circuits, Clampers and Rectifiers. Special purpose diodes, BJTs, FETs and MOSFETS. Biasing circuits for BJTs and FETs. Small signal transistor models. Single transistor amplifiers and Operational amplifiers.

**Prerequisite:** Linear Circuit Analysis

**Prerequisites by Topics:** NIL

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**Prepared by: Dr. Ateeq-Ur-Rehman Shaheen** **Date: Mar. 02, 2020**
**Signature: _____**

**Co-requisite:** NIL

**Textbook:** Electronic Devices and Circuit Theory, Robert L. Boylestad, Louis Nashelsky. **Latest Edition**

**References:**

1. Fundamentals of Microelectronics, Behzad Razavi.
2. Microelectronic Circuits, A. S. Sedra and K. C. Smith, Oxford University Press, **Latest Edition**.
3. Semiconductor Devices, Jim Fry, Heath Company, 3rd Printing edition (1986)

**Program Learning Outcome:**
This course is designed in conjunction with the following PLOs.

**PLO-1 Engineering Knowledge:** An ability to apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

**PLO-2 Problem Analysis:** An ability to identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

**Course Learning Outcome (CLO):**

Upon successful completion of this course, the student will be able to:

| CLO No. | CLO Outline | Taxonomy Domain | Relevant PLO | Assessment |
|---|---|---|---|---|
| 1 | Understand the basic characteristics, theory of operation and applications of semiconductor devices (e.g. Diode, BJT, FET, MOSFET) and Operational Amplifiers. | C - 2 | 1 | A1, Q1, MP1, FP1 |
| 2 | Apply the acquired knowledge to solve the basic electronics circuits with discrete components (resistance, transistor, diode, capacitors) using different DC-biasing technique. | C - 3 | 2 | A2, Q2, MP2, FP2 |
| 3 | Examine (illustrate) the AC response of the BJT and FET amplifiers using device models. | C - 3 | 2 | A3, Q3, FP3 |

**Note:** C – Cognitive, A – Assignment, Q – Quiz, MP – Mid Part, FP – Final Part

**Course Professional Outcome/ Industrial Usage:**

Electronic Davies and Circuits is the core course of the Electrical Engineering Program. It introduces students to the Fundamental of the semiconductor devices like diodes, BJTs, FETs and Operational Amplifiers and varieties of operations, analyses and problems that may arise within the context. It also equips the students with mathematical techniques and skills to handles the electrical circuits in industry.

**Course Outline and Sessions Breakdown:**

**I. Physics of Semiconductors Devices (CLO-1)**
**(6 Sessions)**
Introduction, Semiconductor materials, Semiconductor Diodes, Diode Circuit, Diode Circuit Application, Special Purpose Diodes.

**II. Bipolar Junction Transistors (BJT) and DC Biasing Techniques (CLO-1, 2)**
**(8 Sessions)**
Introduction, Structure, Physical Operation, Characteristics, Modes of Operation, Configurations, Biasing Techniques

**III. Field Effect Transistor (FET) and Biasing Techniques (CLO-1, 2)**
**(4 Sessions)**
Introduction, Construction, Physical Operation, Characteristics, Configurations, Biasing Techniques

**IV. Metal-oxide-semiconductor Field Effect Transistor (MOSFET) (CLO-1, 2)**
**(4 Sessions)**
Introduction, Construction, Physical Operation, Characteristics, Types, Biasing Techniques

**V. BJT and FET Small Signal Analysis (CLO-3)**
**(6 Sessions)**
Introduction, BJT and FET Transistor Modeling, Configurations.

**VI. Operational Amplifiers (CLO-1)**
**(4 Sessions)**
Introduction, Different Types of Op-Amp, Op-Amp Applications, Problems

**Computer Usage:** Not applicable unless otherwise stated.

**Projects / Design Activities:**
Students will be asked to build a circuit using components like resister, transistor, switches, and op-Amps.

**Evaluation Criteria:** Students will be evaluated based on their completion of quizzes, class tests and final exam. Your overall grade will be determined on the following basis.

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|---|---|
| **1.** Assignments | 10% |
| **2.** Quizzes | 15% |
| **3.** Project | 05% |
| **4.** Mid-Term Exam | 20% |
| **5.** Final Exam | 50% |

**Policies**

(a) No makeup tests or quizzes, except in case of emergency, e.g. illness and accident. For makeup tests, medical certificate is required and the instructor must be notified in advance of the test.

(b) No late assignment will be accepted.

(c) Topics and schedule mentioned here are tentative. They may be slightly changed depending on the interest / pace of class.

(d) **Class notes and Handouts:**

Students must take notes in the class. Equations, expressions and problems would be copied from the board as the instructor writes while, the student should note down important points as the instructor delivers the lecture both as orally and through slides. This body of material would form the most important asset of the student for exam preparation and in obtaining good grades. Additional study material supplementing the class notes is the text book. The student must always inculcate the habit of book reading for deepening and strengthening the concepts gained in the class.

(e) **Attendance Policy:**

Class attendance is mandatory. You are expected to be present in all classes. The students having their attendance less than 75% will not be allowed to appear in the exam and will be awarded "F" grade hence forth.

(f) **Homework Policy:**

- You SHOULD NOT copy homework from classmates. You may consult with the instructors or one of your classmates if there is a homework problem that you find difficult.
- Copying assignment will not carry any benefit because quizzes will be based on assignments and most of the assignments will be marked based on quizzes.
- Late homework is not accepted for any reason.
- Homework papers should have a cover page showing name, ID number, date, problem number and assignment number.
- Class serial number should appear on the top right hand corner of the cover page.
- All problems in an assignment set should be arranged sequentially.
- A4 Paper should be used for Assignments.

(g) **Quizzes:**

These will be held promptly on the designated day. They will cover the material taught the previous weeks. Late arrival or non-attendance without a legitimate excuse will mean that you are ineligible to take that quiz.

(h) **Academic Dishonesty:**

The UOS is an academic community whose purpose is the pursuit of knowledge and the development of its graduates as leading experts in their academic disciplines. All members of this community must be committed to the principles of truth and academic honesty. Academic dishonesty includes the following acts committed knowingly or intentionally by the student:

- **Cheating:** Using or attempting to use unauthorized materials and assistance, such as notes, study aids, electronic communication devices of any sort, or any other forms of unauthorized information or consulting any unauthorized sources, in any academic assignment, exercise, or examination.
- **Fabrication:** Falsifying or inventing research, citations, or any information on any academic assignment, exercise, or examination.
- **Plagiarism:** Representing another's words or ideas as one's own or failing to give proper credit to outside sources of information in any academic assignment, exercise, or examination.
- **Facilitating academic dishonesty:** Aiding or assisting another in cheating, fabrication or plagiarism.

Students who have committed an act of academic dishonesty are subject to one or more of the following penalties:

- A written warning
- A reduction in grade for the assignment
- A zero grade for the assignment
- A reduction of grade for the course, including an F grade for the course.
- Suspension from the Wah Engineering College for one or more semesters.
- Expulsion from the Wah Engineering College.

Records of incidents of academic dishonesty will be kept on file at the Wah Engineering College and may be reported to the student's guardian and sponsor.

Students who are in doubt about whether certain academic activities are honest or not should discuss the matter with the course instructor or consult the WEC policy on academic integrity.

**Disclaimer:**

(i) The instructor reserves the right to change, and adjust the policies and class schedules at any time during the semester.

**COURSE DISTRIBUTION ON WEEKLY BASIS**

| **1. Detailed Lecture Plan** | | | |
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| **Week No.** | **Lecture** | **Course contents to be covered** | **Reference** |

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|---|---|---|---|
| **WEEK 01** | 1-2 | Introduction (2 Lectures)<br>Basic physics of semiconductors<br>Covalent bonding and intrinsic materials<br>Semiconductors materials and their properties | Text Book Chapter 1 |
| **WEEK 02** | 3-4 | Semiconductor diode and diode circuits (2 Lectures)<br>Structure and I-V characteristics<br>Ideal diode model<br>Diode circuit analysis<br>Diode circuit applications (Rectifiers, Clipper and Clampers) | Text Book Chapter 1,2 |
| **WEEK 03** | 5-6 | Special types of Diodes (2 Lectures)<br>Structure and characteristics of special purpose diodes (Zener Diode, Light Emitting Diode, Laser Diode, Photo Diode, Tunnel Diode, Varactor Diode) | Text Book Chapter 2 and Lecture Notes |
| **WEEK 04** | 7-8 | Bipolar Junction Transistors (BJT) (2 Lectures)<br>Structure, Physical operation, I-V characteristics, and modes of operation | Text Book Chapter 3 |
| **WEEK 05** | 9-10 | BJT Circuits and Configurations (2 Lectures)<br>Common-Base configuration<br>Common-Emitter configuration<br>Common-Collector configuration | Text Book Chapter 3 |
| **WEEK 06** | 11-12 | BJT DC-Biasing Techniques (2 lectures)<br>Fixed biased configuration<br>Emitter biased configuration<br>Voltage-divider bias configuration<br>Problems | Text Book Chapter 4 |
| **WEEK 07** | 13-14 | BJT DC-Biasing Techniques (2 lectures)<br>Collector feedback configuration<br>Emitter follower configuration<br>Common-Base Configuration.<br>PNP Transistors<br>Problems | Text Book Chapter 4 |
| **WEEK 08** | 15-16 | Field Effect Transistor (FET) (2 lectures)<br>Construction and characteristics of JFETs<br>Transfer Characteristics | Text Book Chapter 6 |

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| **WEEK 09** | **Mid Term Examination** | | |
| **WEEK 10** | 19-20 | FET Biasing Techniques (2 lectures)<br>Fixed biased configuration<br>Self-Bias configuration<br>Voltage-divider bias configuration<br>Problems | Text Book Chapter 7 |
| **WEEK 11** | 21-22 | Metal–oxide–semiconductor Field-effect Transistor (MOSFETS) (2 Lectures)<br>Structure, physical operation, and I-V characteristics.<br>Depletion-Type MOSFET<br>Enhancement-Type MOSFET | Text Book Chapter 6 |
| **WEEK 12** | 23-24 | MOSFET Biasing Techniques (2 lectures)<br>Depletion-Type MOSFETs<br>Enhancement-Type MOSFETs<br>Problems | Text Book Chapter 5 |
| **WEEK 13** | 25-26 | BJT AC Models (2 lectures)<br>Amplification in the AC Domain<br>BJT Transistor Modeling<br>The $r_e$ Transistor Model<br>Common Emitter Fixed-Bias | Text Book Chapter 5 |
| **WEEK 14** | 27-28 | FET Amplifiers (2 lectures)<br>JFET Small-Signal Model<br>Fixed Bias Configuration<br>Self-Bias Configuration | Text Book Chapter 8 |
| **WEEK 15** | 31-32 | Operational Amplifiers (2 lectures)<br>Introduction<br>Op-Amp Basics<br>Inverting Amplifiers<br>Non-inverting Amplifiers | Text Book Chapter 10 |
| **WEEK 16** | 33-34 | Operational Amplifiers (2 lectures)<br>Summing Amplifiers<br>Difference Amplifiers<br>Op-Amp Applications<br>Problems | Text Book Chapter 10,11 |
| **WEEK 17** | **Preparation Holidays** | | |
| **WEEK 18** | **Final Term Examination** | | |