| | | |
|---|---|---|
| | **Ministry of Higher Education and Scientific Research - Iraq**<br>**Al-Naji University**<br>**College of Engineering**<br>**AI Engineering Department** | |

# MODULE DESCRIPTION FORM

## نموذج وصف المادة الدراسية

| **Module Information**<br>معلومات المادة الدراسية | | | | | |
|---|---|---|---|---|---|
| **Module Title** | **Electrical Circuits** | | | **Module Delivery** | |
| **Module Type** | **Core** | | | ☒ **Theory**<br>☐ **Lecture**<br>☒ **Lab**<br>☐ **Tutorial**<br>☐ **Practical**<br>☐ **Seminar** | |
| **Module Code** | **AIA1203** | | | | |
| **ECTS Credits** | **6** | | | | |
| **SWL (hr/sem)** | **150** | | | | |
| **Module Level** | UGI | | **Semester of Delivery** | 2 | |
| **Administering Department** | AI Engineering | | **College** | College of Engineering | |
| **Module Leader** | Dr. Mohammed Ali Tawfeeq | | **e-mail** | mohammed.tawfeeq@alnaji-uni.edu.iq | |
| **Module Leader's Acad. Title** | Professor | | **Module Leader's Qualification** | Ph.D. | |
| **Module Tutor** | | | **e-mail** | | |
| **Peer Reviewer Name** | | | **e-mail** | | |
| **Scientific Committee Approval Date** | | | **Version Number** | 1.0 | |

| **Relation with other Modules**<br>العلاقة مع المواد الدراسية الأخرى | | | |
|---|---|---|---|
| **Prerequisite module** | None | **Semester** | |
| **Co-requisites module** | None | **Semester** | |

| Module Aims, Learning Outcomes and Indicative Contents<br>أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية | |
|---|---|
| **Module Objectives**<br>أهداف المادة الدراسية | 1- Understand the basic concepts of electrical circuits such as current, voltage, resistance, power, and electrical energy.<br>2- Learn about basic electrical components such as resistors, inductors, and capacitors.<br>3- Analyze series and parallel circuits and calculate total resistance, current, and voltage drops.<br>4- Analyze direct current (DC) circuits by applying Kirchhoff's Laws (KCL and KVL) and using analysis methods such as Node Voltage and Mesh Current analysis.<br>5- Use circuit theorems like Superposition, Thevenin's, Norton's, and Maximum Power Transfer to simplify and analyze complex electrical circuits and find equivalent networks.<br>6- Understand and analyze circuits with energy storage elements (inductors and capacitors) by studying the response of first and second-order circuits (RL, RC, RLC), as well as examining the time-domain behavior of circuits during sudden changes (Transient Response).<br>7- Analyze alternating current (AC) electrical circuits. |
| **Module Learning Outcomes**<br>مخرجات التعلم للمادة الدراسية | **After completing this course, the student will be able to:**<br>**I. Knowledge and Understanding**<br>1. Explain the fundamental concepts of electrical circuits such as current, voltage, power, and resistance.<br>2. Describe the characteristics of basic electrical components such as resistors, inductors, and capacitors.<br>3. Understand Kirchhoff's Laws (KCL and KVL) and how to apply them in circuit analysis.<br>4. Recognize and describe series and parallel circuits, including voltage and current distribution and equivalent resistance/capacitance/inductance.<br>5. Understand the fundamental circuit theorems such as Thevenin's, Norton's, Superposition, and Maximum Power Transfer.<br>6. Explain the behavior of electrical circuits in both Direct Current (DC) and Alternating Current (AC) systems.<br>**II. Intellectual Skills (Analysis and Critical Thinking)**<br>7. Analyze electrical circuits using various methods such as Node Voltage and Mesh Current analysis.<br>8. Simplify electrical circuits using different theorems and techniques, including source transformations, equivalent networks, and series-parallel combinations.<br>9. Study and analyze the time-domain response of first- and second-order circuits (RL, RC, RLC).<br>**III. Practical and Applied Skills**<br>10. Apply theories and concepts to real electrical circuits using circuit analysis tools.<br>11. Build and test series and parallel circuits, and evaluate their behavior under |

| | |
|---|---|
| | different conditions.<br>12. Measure and analyze electrical signals using laboratory instruments such as oscilloscopes and multimeters.<br>13. Interpret results and relate them to theoretical expectations.<br>14. Write technical and engineering reports on circuit analysis and clearly present the results. |
| **Indicative Contents**<br>المحتويات الإرشادية | **Core Topics and Estimated Time for Completion**<br><br>**Unit 1: Fundamentals of Electrical Circuits (3 weeks – 9 hours)**<br><br>- Basic concepts: charge, current, voltage, resistance, power, and energy.<br>- Ohm's Law and the relationship between voltage, current, and resistance.<br>- Introduction to electrical components: resistors, inductors, and capacitors.<br>- Kirchhoff's Current and Voltage Laws (KCL & KVL).<br><br>**Unit 2: DC Circuit Analysis (5 weeks – 15 hours)**<br>- Circuit analysis using Kirchhoff's Laws.<br>- Node Voltage Method.<br>- Mesh Current Method.<br>- Source transformations and equivalent resistances.<br>- Application of network theorems:<br>• Superposition Theorem<br>• Thevenin's and Norton's Theorems<br>• Maximum Power Transfer Theorem<br><br>**Unit 3: Energy Storage Elements and First- & Second-Order Circuits (3 weeks – 9 hours)**<br>- Behavior of inductors and capacitors in electrical circuits.<br>- Analysis of first-order (RC and RL) circuits.<br>- Transient response of circuits to time-varying voltage and current.<br><br>**Unit 4: AC Circuits and Frequency-Domain Analysis (3 weeks – 9 hours)**<br>- Mathematical representation of AC voltage and current using phasors.<br>- Concepts of resistance, impedance, and admittance.<br>- AC circuit analysis using node and mesh techniques.<br>- Power in AC circuits: real power, reactive power, and power factor.<br>- Power factor improvement using capacitors. |

| **Learning and Teaching Strategies**<br>استراتيجيات التعلم والتعليم | |
|---|---|
| **Strategies** | - **Learning Strategies (for Students)**<br>1. **Active Learning**<br>- Practice solving problems regularly.<br>- Use circuit simulation tools like Multisim or LTspice. |

| | |
|---|---|
| | 2. **Visualization Techniques**<br>- Use color coding for voltage, current, and resistance in circuit diagrams.<br>- Create concept maps linking Ohm's Law, Kirchhoff's Laws, and other key concepts.<br>3. **Study Groups**<br>- Collaborate with peers to discuss problems and different solution strategies.<br>4. **Real-World Applications**<br>- Connect theory to practical examples (e.g., how voltage dividers are used in sensors).<br>5. **Flashcards & Quizzes**<br>- Use for formulas, symbols, units, and key terms (e.g., resistance, impedance).<br>6. **Analogies & Simplification**<br>- Compare electric circuits to water flow to better understand current and voltage.<br><br>**-Teaching Strategies (for Instructors)**<br>1. **Problem-Based Learning (PBL)**<br>- Present students with real-world problems to solve using circuit concepts.<br>2. **Interactive Simulations**<br>- Incorporate tools like Multisim or LTspice in lessons.<br>3. **Hands-On Labs**<br>- Use breadboards, basic components, and measurement tools (multimeters, oscilloscopes) for real circuit building.<br>4. **Scaffolded Learning**<br>- Start with basic laws (Ohm's, Kirchhoff's) and build up to AC circuits and complex networks.<br>5. **Formative Assessments**<br>- Use quick in-class quizzes or polls to check understanding during lectures.<br>6. **Flipped Classroom**<br>- Assign video lessons or reading before class; use class time for discussions and problem-solving.<br>7. **Use of Technology**<br>- Use Google Classroom to share resources, quizzes, and discussions.<br>8. **Scenarios and Case Studies**<br>- Discuss electrical failures, power systems, or consumer electronics to apply concepts in context.<br>9. **Feedback & Reflection**<br>- Encourage peer reviews of lab work and self-assessment exercises. |
| | |

| Student Workload (SWL)<br>الحمل الدراسي للطالب محسوب لـ 15 اسبوعا | | | |
|---|---|---|---|
| **Structured SWL (h/sem)**<br>الحمل الدراسي المنتظم للطالب خلال الفصل | 78 | **Structured SWL (h/w)**<br>الحمل الدراسي المنتظم للطالب أسبوعيا | 5 |
| **Unstructured SWL (h/sem)**<br>الحمل الدراسي غير المنتظم للطالب خلال الفصل | 72 | **Unstructured SWL (h/w)**<br>الحمل الدراسي غير المنتظم للطالب أسبوعيا | 4.8 |
| **Total SWL (h/sem)**<br>الحمل الدراسي الكلي للطالب خلال الفصل | **125** | | |

| Module Evaluation<br>تقييم المادة الدراسية | | | | | |
|---|---|---|---|---|---|
| | | **Time/Number** | **Weight (Marks)** | **Week Due** | **Relevant Learning Outcome** |
| **Formative assessment** | **Quizzes** | 4 | 10% (10) | 2,5,10,14 | LO #1 - #9 |
| | **Assignments** | 3 | 10% (10) | 2 ,8, 13 | LO #1 - #9 |
| | **Lab** | 1 | 15% (15) | Continuous | All |
| | **Report** | 1 | 5% (5) | 15 | LO #1 - #9 |
| **Summative assessment** | **Midterm Exam** | 2hr | 10% (10) | 7 | LO #1 - #7 |
| | **Final Exam** | 3hr | 50% (50) | 16 | All |
| **Total assessment** | | | 100% (100 Marks) | | |

| Delivery Plan (Weekly Syllabus)<br>المنهاج الاسبوعي النظري | |
|---|---|
| | **Material Covered** |
| **Week 1** | **Fundamentals of Electrical Circuits: (Week 1-3)**<br>Basic concepts: charge, current, voltage, resistance, power, and energy. |
| **Week 2** | Ohm's Law and the relationship between voltage, current, and resistance. Introduction to electrical components: resistors, inductors, and capacitors. |
| **Week 3** | Series and parallel circuits. Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL). |
| **Week 4** | **DC Circuit Analysis: (Week 4-9)**<br>Circuit analysis using Kirchhoff's Laws: Node Voltage Method . Mesh Current Method. |
| **Week 5** | Source transformations and equivalent resistances. |
| **Week 6** | Network theorems: Superposition Theorem. |
| **Week 7** | Network theorems: Thevenin's Theorem |
| **Week 8** | Network theorems: Norton's Theorem |

| | |
|---|---|
| **Week 9** | **Midterm Exam +** Maximum Power Transfer Theorem |
| **Week 10** | **Energy Storage Components and 1st and 2nd Order Circuits:(Week 10-12)**<br>Behavior of inductors and capacitors in circuits. |
| **Week 11** | First-order circuits: RC and RL circuits. Transient response of circuits to step inputs. |
| **Week 12** | Second-order circuits: RLC circuits and oscillatory response. |
| **Week 13** | **AC Circuits and Frequency Domain Analysis: (Week 13-15)**<br>Mathematical representation of AC signals using phasors. Concept of impedance and admittance. |
| **Week 14** | Circuit analysis using node voltage and mesh current methods in AC circuits. |
| **Week 15** | AC power: real power, reactive power, and power factor. Power factor correction using capacitors. |
| **Week 16** | **Preparatory week before the final Exam** |

| **Delivery Plan (Weekly Lab. Syllabus)**<br>المنهاج الاسبوعي للمختبر | |
|---|---|
| | **Material Covered** |
| **Week 1** | Lab 1: Introduction to Electrical circuits and circuit elements. |
| **Week 2** | Lab 2: Ohm's law. |
| **Week 3** | Lab 3: Kirchhoff's Voltage/Current Laws. |
| **Week 4** | Lab 4: Series connections. |
| **Week 5** | Lab 5: Parallel connections. |
| **Week 6** | Lab 6: Voltage divider and current divider circuits |
| **Week 7** | Lab 7: Evaluating circuits using nodal analysis. |
| **Week 8** | Lab 8: Evaluating circuits using mesh analysis |
| **Week 9** | Lab 9: Simplifying circuits into Thevenin equivalent circuit. |
| **Week 10** | Lab 10: Obtaining equivalent resistance, currents and voltages using Norton Theorem. |
| **Week 11** | Lab 11: Analyze various RL, RC and RLC circuits. |

## Learning and Teaching Resources
مصادر التعلم والتدريس

| | Text | Available in the Library? |
|---|---|---|
| **Required Texts** | Fundamentals of Electric Circuits, C.K. Alexander and M.N.O Sadiku, McGraw-Hill Education<br>Basic Engineering Circuit Analysis by J. David Irwin and Robert M. Nelms, 12th Edition 2021. | Yes |
| **Recommended Texts** | DC Electrical Circuit Analysis: A Practical Approach<br>Copyright Year: 2020. | No |
| **Websites** | Google Classroom | |

## Grading Scheme
مخطط الدرجات

| Group | Grade | التقدير | Marks % | Definition |
|---|---|---|---|---|
| **Success Group (50 - 100)** | **A** - Excellent | امتياز | 90 - 100 | Outstanding Performance |
| | **B** - Very Good | جيد جدا | 80 - 89 | Above average with some errors |
| | **C** - Good | جيد | 70 - 79 | Sound work with notable errors |
| | **D** - Satisfactory | متوسط | 60 - 69 | Fair but with major shortcomings |
| | **E** - Sufficient | مقبول | 50 - 59 | Work meets minimum criteria |
| **Fail Group (0 – 49)** | **FX** – Fail | راسب (قيد المعالجة) | (45-49) | More work required but credit awarded |
| | **F** – Fail | راسب | (0-44) | Considerable amount of work required |
| | | | | |

**Note:** Marks Decimal places above or below 0.5 will be rounded to the higher or lower full mark (for example a mark of 54.5 will be rounded to 55, whereas a mark of 54.4 will be rounded to 54. The University has a policy NOT to condone "near-pass fails" so the only adjustment to marks awarded by the original marker(s) will be the automatic rounding outlined above.