# MODULE DESCRIPTION FORM

نموذج وصف المادة الدراسية

| Module Information | | | | | |
|---|---|---|---|---|---|
| **Module Title** | **Control systems** | | | **Module Delivery** | |
| **Module Type** | **Core** | | | ☒ **Theory** | |
| **Module Code** | **PM 402** | | | ☐ **Lecture** | |
| **ECTS Credits** | **6** | | | ☐ **Tutorial** | |
| **SWL (hr/sem)** | **150** | | | ☒ **Practical** | |
| | | | | ☐ **Seminar** | |
| **Module Level** | **4** | **Semester of Deliver** | **8** | | |
| **Administering Department** | **PM** | **College** | **TEMO** | | |
| **Module Leader** | **Prof. Dr. Haitham M. Wadullah** | **e-mail** | **Dr.haitham@ntu.edu.iq** | | |
| **Module Leader's Acad. Title** | **Prof.** | **Module Leader's Qualification** | **PhD** | | |
| **Module Tutor** | | **e-mail** | **Dr.haitham@ntu.edu.iq** | | |
| **Peer Reviewer Name** | **Name** | **e-mail** | **E-mail** | | |
| **Scientific Committee Approval Date** | **1/6/2023** | **Version Number** | **1.0** | | |

| Relation with other Modules | | | |
|---|---|---|---|
| **Prerequisite module** | **None** | **Semester** | |
| **Co-requisites module** | **None** | **Semester** | |

| Module Aims, Learning Outcomes and Indicative Contents | |
|---|---|
| **Module Objectives** | 1. Understanding Measurement Principles: Gain knowledge of measurement principles, including device selection, calibration, and measurement limitations.<br>2. Familiarity with Control Systems: Learn the basics of control systems, including feedback, closed-loop control, and the role of sensors, actuators, and controllers.<br>3. Application of Measurement Techniques: Develop practical skills in using measurement techniques and instruments to collect and analyze data in engineering systems.<br>4. System Analysis and Optimization: Acquire the ability to analyze measurement and control systems, identify performance issues, and implement optimization strategies for enhanced system performance. |
| **Module Learning Outcomes** | 1. Understand Measurement Principles: Develop a solid understanding of the fundamental principles of measurement, including accuracy, precision, and uncertainty. Gain the ability to choose appropriate measurement devices and methods for different engineering applications. |

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| | 2. Analyze and Design Control Systems: Acquire the skills to analyze and design control systems, including feedback loops, controllers, and actuators. Grasp concepts such as stability, transient response, and steady-state error in control systems.<br>3. Apply Measurement Techniques: Gain practical expertise in applying measurement techniques and instruments to collect and analyze data in engineering systems. Utilize statistical methods to effectively analyze and interpret measurement data.<br>4. Troubleshoot and Optimize Systems: Develop the ability to troubleshoot and optimize engineering systems by identifying and rectifying measurement and control issues. Learn techniques for system optimization to enhance performance and efficiency. |
| **Indicative Contents** | Part A:<br>Fundamentals of measurement systems, General Measurement System, Error and uncertainty analysis and Static characteristics of measurement system elements [25 hours]<br><br>Introduction to control system, Power circuit elements, Principles of electric control and Plc basics [25 hours]<br><br>Revision Session and Quiz [2 hours]<br><br>Part B: 4.<br>tutorial of symbols, equipment's and Counters, timers, introduction to inverter [25 hours]<br>PLC system structure, Basic ladder logic Timers, Counters & Comparators [25 hours]<br><br>Up Counter (CTU), Down Counter (CTD), Latch and Unlatch Logic Memory Concept in Allen Bradley PLC, and Hardware of PLC circuit, review of PLC ladder. [25 hours]<br><br>Revision Session and Quiz [2 hours]<br><br>Revised Description: Part A of the Engineering Measurement and Control Systems course provides students with a solid understanding of the fundamental principles in this field. The module begins by covering the basics of measurement, including different measurement techniques and the use of instruments. Students will then delve into the topic of control systems and explore considerations related to Programmable Logic Controllers (PLCs). To reinforce the learned concepts, a revision session and quiz will be conducted, allowing students to review and assess their understanding. This module serves as a crucial foundation for further studies in the field of Engineering Measurement and Control Systems. |

| Learning and Teaching Strategies | |
|---|---|
| **Strategies** | 1. Active Participation: Actively engage in class discussions, ask questions, and contribute to group activities. This will help you better understand the concepts and reinforce your learning.<br>2. Practical Application: Apply the theoretical knowledge to real-world examples and projects. Participate in laboratory sessions and hands-on activities to gain practical experience in measurement and control systems.<br>3. Problem-Solving Approach: Develop strong problem-solving skills by practicing solving different types of measurement and control problems. Work on assignments and projects that require critical thinking and analytical skills |

| Student Workload (SWL) | | | |
|---|---|---|---|
| **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** | **5** |
| **Total SWL (h/sem)**<br>**الحمل الدراسي الكلي للطالب خلال الفصل** | **150** | | |

| Module Evaluation | | | | | |
|---|---|---|---|---|---|
| **As** | | **Time/Number** | **Weight (Marks)** | **Week Due** | **Relevant Learning Outcome** |
| **Formative assessment** | **Quizzes** | **2** | **10% (10)** | 5 and 10 | LO #1and #2 |
| | **Assignments** | **2** | **5% (5)** | 2 and 12 | LO #2 and #3 |
| | **Projects / Lab.** | **9** | **15% (15)** | Continuous | LO #1 and #3 |
| | **Report** | **1** | **10% (10)** | 13 | LO #3 |
| **Summative assessment** | **Midterm Exam** | **2hr.** | **10% (10)** | 7 | LO #1 - #2 |
| | **Final Exam** | **2hr.** | **50% (50)** | 16 | All |
| **Total assessment** | | | **100% (100 Marks)** | | |

| Delivery Plan (Weekly Syllabus) | |
|---|---|
| **Week** | **Material Covered** |
| **Week 1** | Fundamentals of measurement systems<br>- Definition of measurement and instrumentation<br>- Significance of measurement |
| **Week 2** | General Measurement System<br>- Functions of instrument in measurements<br>- Calibration and standards |
| **Week 3** | Error and uncertainty analysis<br>- Errors in Measurements<br>- Accuracy and precision<br>- Sources of errors |
| **Week 4** | Static characteristics of measurement system elements<br>- Characteristics of instruments<br>- Static characteristics of measuring system<br>- Environmental effects |
| **Week 5** | Introduction to control system<br>- Types of Control System<br>- Block Diagrams |
| **Week 6** | Introduction to Block Diagrams<br>- Block Diagram Reduction Rules |
| **Week 7** | Power circuit elements Circuit breaker Overload Relay |
| **Week 8** | Contactor |
| **Week 9** | Principles of electric control, components, elements, sensors, electric relays, controlled devices (final elements) , switches, power & control circuits , planning (mapping).. |
| **Week 10** | Plc basics, tutorial of symbols, equipment's |
| **Week 11** | Counters, timers, introduction to inverter |
| **Week 12** | PLC system structure, Basic ladder logic<br>Timers, Counters & Comparators |
| **Week 13** | Up Counter (CTU) , Down Counter (CTD) |
| **Week 14** | Latch and Unlatch Logic<br>Memory Concept in Allen Bradley PLC |
| **Week 15** | Hardware of PLC circuit, review of PLC ladder |
| **Week 16** | Final Examination |

| Delivery Plan (Weekly Lab. Syllabus) | |
|---|---|
| **Week** | **Material Covered** |
| **Week 1** | Over view on the control workshop , tools, and measuring devices |
| **Week 2** | Knowledge of connection & operation of the measuring devices for temperature, pressure, humidity, fluid flow. |
| **Week 3** | Built electric circuit (power & control) for domestic refrigerator or freezer and checking before operating the circuit. |
| **Week 4** | Built electric circuit (power & control) for domestic water cooler and checking before operating the circuit. |
| **Week 5** | Built electric circuit (power & control) for domestic window type A/C for cooling and checking before operating the circuit. |
| **Week 6** | Built electric circuit (power & control) for domestic window type A/C for cooling & heating, and checking before operating the circuit. |
| **Week 7** | Built electric circuit (power & control) for domestic defrost refrigerator and checking before operating the circuit. |
| **Week 8** | Built electric circuit (power & control) for domestic clothes washer and checking before operating the circuit. |
| **Week 9** | Check and calibration of thermal expansion valve. |
| **Week 11** | Check and calibration for the contacts of the electric contactor & thermal switch. |
| **Week 12** | Built a control circuit for motor power circuit (ON-OFF) start and stop from one location. |
| **Week 13** | Built a control circuit for motor power circuit (ON-OFF) start and stop from two deferent locations. |
| **Week 14** | Built a control circuit for motor power circuit (star-delta) rotate in one direction, and other in two directions. |
| **Week 15** | Practical study of the PLC gets. |

| Learning and Teaching Resources | | |
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| | **Text** | **Available in the Library?** |
| **Required Texts** | 1. "Measurement and Control Basics" by Thomas A. Hughes<br>2. "Principles of Measurement Systems" by John P. Bentley<br>3. "Industrial Instrumentation and Control Systems" by William C. Dunn<br>4. "Process Control: A Practical Approach" by Myke King | yes |
| **Recommended Texts** | 1. "Instrumentation and Control Systems Documentation" by Fred A. Meier<br>2. "Control Systems Engineering" by Norman S. Nise<br>3. "Automatic Control Systems" by Benjamin C. Kuo and Farid Golnaraghi<br>4. "Modern Control Engineering" by Katsuhiko Ogata<br>5. "Instrumentation for Process Measurement and Control" by Norman A. Anderson<br>6. "Introduction to Control System Technology" by Robert N. Bates | yes |
| **Websites** | 1. National Instruments: www.ni.com<br>2. Automation.com: www.automation.com<br>3. ControlGlobal: www.controlglobal.com<br>4. ISA - International Society of Automation: www.isa.org<br>5. Omega Engineering: www.omega.com<br>6. Emerson Automation Solutions: www.emerson.com | |

| Grading Scheme<br>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.**

**Module 1**

| Code | Course/Module Title | ECTS | Semester |
|---|---|---|---|
| **PM 402** | **Control systems** | **6** | **4** |
| **Class (hr/w)** | **Lect/Lab./Prac./Tutor** | **SSWL (hr/sem)** | **USWL (hr/sem)** |
| **2** | **3** | **78** | **72** |
| **Description** | | | |

**Control systems** involve the application of various techniques and technologies to measure, monitor, and control physical variables and processes in industrial, engineering, and scientific applications. This field encompasses the design, implementation, and optimization of systems that ensure accurate and reliable measurements, as well as effective control of processes.

Measurement and Control Systems play a crucial role in industries such as manufacturing, power generation, automation, and instrumentation. They involve sensors, transducers, data acquisition systems, signal processing techniques, and control algorithms. These systems enable precise measurement of variables like temperature, pressure, flow rate, and level, and utilize control strategies to regulate and optimize processes.

Understanding Measurement and Control Systems requires knowledge of sensors, data acquisition methods, signal conditioning, measurement principles, control theory, and instrumentation. Professionals in this field need to analyze system behavior, design control algorithms, implement hardware and software components, and troubleshoot issues.

This field is constantly evolving with advancements in technology, such as the integration of Internet of Things (IoT), machine learning, and cloud computing. Measurement and Control Systems are vital for ensuring efficiency, safety, and reliability in various industries, making it a critical area of study for engineers and scientists.